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# SELECTED WATER RESOURCES ABSTRACTS

VOLUME 15, NUMBER 7
JULY 1, 1982

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A monthly publication of the Office of Water Research and Technology,
U.S. Department of the Interior

**VOLUME 15, NUMBER 7**
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W82-03001 -- W82-03400

The Secretary of the Interior has determined that the publication of the periodical is necessary in the transaction of the public business required by law of this Department.

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

# PREFACE

**Selected Water Resources Abstracts,** a monthly journal, includes abstracts of current and earlier pertinent monographs, journal articles, reports, and other publication formats. These documents cover water resources as treated in the life, physical, and social sciences and the related engineering and legal aspects of the characteristics, supply condition, conservation, control, use, or management of water resources. Each abstract includes a full bibliographic citation and a set of descriptors which are listed in the **Water Resources Thesaurus.** The abstract entries are classified into 10 fields and 60 groups similar to the water resources research categories established by the Committee on Water Resources Research of the then Federal Council for Science and Technology.

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Comments and suggestions concerning the contents and arrangement of this bulletin are welcome.

Office of Water Research and Technology
U.S. Department of the Interior
Washington, D.C. 20240

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# SELECTED WATER RESOURCES ABSTRACTS

## 1. NATURE OF WATER

### 1A. Properties

**WATER TEMPERATURE DYNAMICS IN EXPERIMENTAL FIELD CHANNELS: ANALYSIS AND MODELING,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
H. G. Stefan, J. Gulliver, A. Y. Fu, and M. G. Hahn.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-218349, Price codes: A09 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S3-81-008, July, 1981. 6 p, 2 Fig, 1 Tab.

Descriptors: *Water temperature, *Simulation analysis, *Weather, *Channels, Heat transfer, *Thermodynamics, Wind, Microenvironment, Computer models, *Thermal pollution, Model studies, Ecological effects.

The hydraulic and temperature environment in the shallow field channels of the Monticello Ecological Research Station (MERS) was measured and simulated to provide some background for several biological studies, including one on the effects of artificially high water temperatures. An analysis of the temperature measurement problem, the channel temperature regime, microhabitat conditions, and temporal and spatial water temperature dynamics was essential. A dynamic stream temperature simulation model (MNSTREM) with a 3-hour time resolution was developed and verified to give predictions with a standard error of only 0.2 to 0.3 degrees C. A data-bank of 3-hour water temperature data was developed and analyzed statistically. A wind speed function, essential for the correct prediction of water temperature, was developed from on-site meterological and water temperature data. Longitudinal dispersion in the channels and heat transfer into the bed material below the pools of the experimental channels were measured. A computer simulation program (TSOIL) to predict the unsteady water temperature distribution in the three-layered system was also developed. The results of this study are also applicable to the study of temperature dynamics in thermally polluted shallow streams, to the design of canals for cooling water disposal, and to the study of natural water temperature regimes of small streams. (Moore-SRC)
W82-03025

**A PROBLEM POSED BY VAPOUR-DOMINATED GEOTHERMAL SYSTEMS,**
California Univ., Los Angeles. Dept. of Earth Sciences.
G. Schubert, J. M. Straus, and M. A. Grant.
Nature (London), Vol 287, No 5781, p 423-425, October, 2, 1980. 2 Fig, 8 Ref.

Descriptors: *Geothermal studies, *Steam, *Permeability, *Thermal water, Geothermal resources, Water vapor, Rocks, Condensates, Groundwater, Perched groundwater, Kamojang geothermal field, *Indonesia.

An analysis is presented of the gravitational stability of water over steam in a porous medium. Pressure measurements in wells drilled to different depths have revealed the basic structure of vapor-dominated systems. The near surface condensate layer of a vapor-dominated geothermal system can be stably maintained above the main steam reservoir by restoring forces associated with the displacement of the phase-change interface. Relatively low permeability is required near the condensate layer-steam zone interface to keep the water from falling down into the underlying region of steam. Any stabilization is possible for a non-zero permeability value. If the interface behaved in a manner similar to the boundary between immiscible fluids, the rocks would have to be impermeable to keep the condensate layer from falling down. Under typical conditions, the stability can be maintained, provided that the permeability of the rocks at the depth of the steam-water boundary does not exceed about 40 sq nm. This stability requirement is what determines the thickness of the condensate layer or the distance between the steam reservoir and the surface. (Small-FRC)
W82-03200

**COMPLETE VITRIFICATION IN PURE LIQUID WATER AND DILUTE AQUEOUS SOLUTIONS,**
Innsbruck Univ. (Austria). Inst. for Inorganic and Analytic Chemistry.
P. Bruggeller, and E. Mayer.
Nature, Vol 288, No 5791, p 569-571, December 11, 1980. 4 Fig, 16 Ref.

Descriptors: *Ice, *Freezing, *Vitrified water, Physical properties, Emulsions, *Aqueous solutions, *Pure water, Comparison studies.

Pure liquid water was vitrified by jet-freezing 1-5 micrometer aqueous droplets of emulsion made by sonifying 0.03 g Span 65 (surfactant), 9 ml n-heptane, and (1) 1 ml pure liquid water or (2) 1 ml 0.10 M aqueous CuC12 solution. 5 ml emulsion were jetted through a glass tube with 50 micrometer aperture at 100 atmospheres working pressure into 120 ml vigorously stirred liquid ethane at 90 K. The essential 40 K supercooling effect was achieved. The vitrification of both water and CuC12 solution was demonstrated by differential thermal analysis warm-up curves as well as by X-ray diffraction and ESR spectroscopy. The exothermic peak occurred at 150 K, the temperature reported for the devitrification of amorphous ice prepared from water vapor. (Cassar-FRC)
W82-03361

**WAKE COLLAPSE IN THE THERMOCLINE AND INTERNAL SOLITARY WAVES,**
Catholic Univ. of America, Washington, DC. Dept. of Civil Engineering.
T. W. Kao, and H-P. Pao.
Journal of Fluid Mechanics, Vol 97, No 1, 115-127, March, 1980. 9 Fig, 3 Tab, 9 Ref.

Descriptors: *Thermocline, *Waves, *Wave velocity, Wavelengths, Mixing, Stratification, Wave action, Wave direction.

The collapse of a mixed region at mid-depth of a thermocline-type stratification was investigated experimentally, in which the extent of the mixed region was generally larger than the scale of the thermocline thickness. Following the collapse, two solitary wave-like disturbances were created, one propagating to the right and the other to the left. Detailed measurements were made of the propagation speed and structure of these waves and their collisions with others were noted. Hot-film anemometry and streak pictures were used. Using Benney's method, an analytical solution was obtained for a solitary wave in a thermocline stratification for a medium of finite total depth. The solution was valid for shallow water. There was excellent agreement between experimental and calculated results, which confirmed that the disturbances were solitary waves obeying the Korteweg-de Vries equation. (Small-FRC)
W82-03365

### 1B. Aqueous Solutions and Suspensions

**AN ION-ASSOCIATION MODEL FOR ESTIMATING ACIDITY CONSTANTS (AT 25 C AND 1 ATM PRESSURE) IN ELECTROLYTE MIXTURES RELATED TO SEAWATER (IONIC STRENGTH < 1 MOL/KG H20),**
Marine Biological Association of the United Kingdom, Plymouth (England).
A. G. Dickson, and M. Whitfield.
Environmental Science and Technology, Vol 15, No 10, p 1155-1164, October, 1981. 5 Fig, 4 Tab, 66 Ref.

Descriptors: *Model studies, *Seawater, *Ions, Equilibrium, Natural waters, Acids, Bases, Chemical reactions, Chemical properties, Salinity, Thermodynamics, Electrolytes.

In addition to interpreting the electrolytic properties of seawater, the Garrels and Thompson ion-association model has been modified to explain the major acid-base systems present in seawater. The data for the activity coefficients of the species examined are presented as a function of ionic strength. The model may be applied to solutions with ionic strengths ranging from 0 to 1 mol/kg H20, allowing the prediction of various equilibrium thermodynamic parameters for natural waters. The model was used under conditions simulating a variety of ionic strengths to estimate the stoichiometric acidity constants of the major weak acids which are found in seawater. Results showed good agreement (all within 10%) between experimental and model estimates. Improvement of the model through a combined interaction and association approach is recommended. (Geiger-FRC)
W82-03194

**THE CONCENTRATION AND ISOTOPIC FRACTIONATION OF GASES DISSOLVED IN FRESHWATER IN EQUILIBRIUM WITH THE ATMOSPHERE. 1. OXYGEN,**
Amherst Coll., MA. Dept. of Physics.
B. B. Benson, and D. Krause, Jr.
Limnology and Oceanography, Vol 25, No 4, p 662-671, July, 1980. 1 Fig, 3 Tab, 23 Ref.

Descriptors: *Dissolved oxygen, *Isotope fractionation, *Solubility coefficient, Oxygen, Equilibrium, Physical properties.

Concentrations of oxygen dissolved in freshwater in equilibrium with the atmosphere from 0 to 40 C and 0.5 to 1.1 atmosphere may be obtained from the equations and tables presented. The values are based on values for the Henry coefficient of oxygen, which have an accuracy of 0.02%. Equations which relate the Henry coefficient to equilibrium concentrations in natural waters include corrections for molecular interactions in the vapor phase. Estimated accuracy of these derived values is 0.07% at 0 C and 0.04% at 40 C, more accurate than values in UNESCO tables. An equation is given to determine the difference between the 034:032 abundance ratio in the dissolved gas and the air under equilibrium conditions between 0 and 60 C. (Cassar-FRC)
W82-03325

## 2. WATER CYCLE

### 2A. General

**EXPERIMENTAL STUDIES OF THE EFFECTS OF EPHEMERAL STREAMFLOW DEPTHS ON INFILTRATION,**
Stanford Univ., CA.
J. W. Reeder.
PhD Dissertation, 1981. 197 p, 42 Fig, 108 Ref, 3 Append. University Microfilms International, Ann Arbor, MI; Order No GAX81-15823.

Descriptors: *Ephemeral streams, *Model studies, *Mathematical models, *Infiltration, Stream discharge, Soil water, Infiltration rate, Surface-groundwater relations, Green-Ampt Model.

The objectives were to gain insight into the complex interactions between ephemeral stream flow and subsurface hydrology, and to develop an understanding and tools necessary to permit the management of ephemeral stream systems and the aquifers they recharge. The Green-Ampt model in comparison with the Richards numerical model was shown to be a workable tool for representing one-dimensional infiltration under the action of fluctuating water depths. It was found that the value of the effective suction head at the lower end of the Green-Ampt saturated slug decreases with respect to time, decreases with respect to greater initial uniform soil-moisture content, and increases with respect to water depth. A theoretical basis for the Green-Ampt model was derived, where the vertical flux in a wetting soil-moisture profile was assumed not to be a function of vertical position. The errors in total infiltration or infiltration rate caused by using constant effective suction heads in the Green-Ampt model may be reduced to accept-

able levels by using appropriate suction values. The range of these errors are larger for smaller or zero surface-water depths than for larger surface-water depths for a given range of effective suction heads. The Green-Ampt model may be used successfully to represent one-dimensional infiltration under rapidly varying surface-water depths; where the best choice of a constant effective suction head depends upon the particular problem or application of the model. (Sinha-OEIS)
W82-03013

**WORTH OF SHORT-TERM RAINFALL FORECASTING FOR COMBINED SEWER OVERFLOW CONTROL,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
J. W. Labadie, R. C. Lazaro, and D. M. Morrow.
Water Resources Research, Vol 17, No 5, p 1489-1497, October, 1981. 10 Fig, 4 Tab, 21 Ref.

Descriptors: *Model studies, *Storm-overflow sewers, Sewers, Combined sewer overflows, Storms, Storm water, Storm runoff, Rainfall-runoff relationships, Mathematical models, *Rainfall forecasting, *Sewer overflow control, Case studies, San Francisco.

The San Francisco Master Plan for Wastewater Management was used as a case study to evaluate real-time, short-term rainfall forecasting as a valuable input to more effective performance of a variety of urban water management activities such as controlling the incidence of untreated combined sewer overflows. The forecasting model is described, and an indication is offered of what kinds of forecast errors can be expected for the San Francisco area. An attempt is then made to tie these results to some concurrent work on measuring the performance of a simulated real time automatic control system as a function of degree of forecast error. For this last task inflow hydrographs with a range of error deviations from the real event input to the control model in order to determine what effect these errors would have on the performance of the resulting control strategies. A split data technique was used to gain insight into expected forecast errors for selected overflow producing storms varying from high intensity-low duration to low intensity-high duration. These results were compared with the performance of the planned system. The results of a limited number of simulation runs indicated that expected forecast model errors are generally lower than the error threshold above which reactive policies become more attractive. (Baker-FRC)
W82-03075

**CORRELATION OF OXYGEN 18 IN PRECIPITATION WITH TEMPERATURE AND ALTITUDE,**
Bern Univ. (Switzerland). Physikalisches Inst.
U. Siegenthaler, and H. Oeschger.
Nature (London), Vol 285, NO 5763, p 314-316, May 29, 1980. 3 Fig, 1 Tab, 10 Ref.

Descriptors: *Oxygen, *Precipitation, *Temperature, Altitude, *Switzerland, Chemistry of precipitation, Oxygen isotopes, Climates, *Isotopes studies, Water vapor, Rainfall, Alps.

Although the O18/O16 ratio in precipitation is correlated to climatic parameters, the meteorological processes determining the stable isotope composition of precipitation are complex and not fully understood. Monthly samples collected at five stations in the network of the Swiss Meteorological Service permit correlation of meteorological data with O18/O16 results. Three of the stations are located at various altitudes in a valley, one is located away from the direct influence of the mountains, and one is on the southern side of the Alps. The long-term mean values of O18 variations were relatively well correlated with temperature at different stations. There is also a good correlation between the variation in O18 and altitude for locations on the Swiss plateau and in the Western Alps. Lower isotopic values were found on the lee side of a mountain range than on the weather side. Analysis of monthly data demonstrates that temperature alone cannot explain the whole variability of O18. O18 enrichment due to evaporation of the falling raindrops depends on the prevailing vapor pressure and is therefore more effective at higher temperatures. The evaporative altitude effect is expected to be larger in summer than in winter as a result of the assumed poor O18 enrichment of snowflakes. The relationship between the variation in O18 and temperature can be partly explained by considering the formation of precipitation as a Rayleigh process. Additional studies over larger geographical areas are needed to increase understanding of the processes affecting 108 variation in precipitation. (Carroll-FRC)
W82-03203

**SIZING OF URBAN FLOOD CONTROL PONDS,**
University of the Witwatersrand, Johannesburg (South Africa). Hydrological Research Unit.
M. D. Watson.
Civil Engineer in South Africa, Vol 23, No 5, p 183-189, May, 1981. 4 Fig, 1 Tab, 10 Ref.

Descriptors: *Flood-control storage, *Model studies, Flood protection, Floodproofing, Ponds, Flood hydrographs, Flood control, Urban watersheds.

Proper usage of ponds for flood control is discussed. The storage volume in the pond is usually designed to reduce the peak discharge of a given recurrence interval to a predetermined level. Given the available pond volume, perhaps predetermined by site conditions, the reduction in peak flow that can be achieved for various recurrence intervals may be assessed. If the outflow rate is assumed to be constant, then for an inflow of a given duration, the required storage volume needed may be determined. As a final step in flood control structure design, an analysis should be made of the continuous record of stream flows, routing them through the proposed storage structure and determining the frequency of functional failure. If flow data are not available, continuous simulation of a long rainfall record may be used to synthesize inflows. In most cases, however, continuous records of neither flow nor rainfall are readily available, and the designer has to resort to synthesizing a design storm which must then be routed through the catchment. After satisfying depression and infiltration losses, it will yield the inflow hydrograph of a certain recurrence interval. This procedure is repeated for different storm durations and storm types to determine the critical inflow hydrograph. Implicit in this procedure is the assumption that storm and runoff recurrence intervals are the same. This method neglects catchment routing and in this respect is conservative. It also assumes that outflow rate is constant. Despite these limitations, the method is a valuable tool for preliminary designs. It allows assessment of the feasibility of a flood control pond without excessive calculations. Its application for final design should be limited to small ponds and applied with conservative estimation of the runoff coefficient. (Baker-FRC)
W82-03297

## 2B. Precipitation

**RAINFALL PREDICTION-MEASUREMENT SYSTEMS AND RAINFALL DESIGN INFORMATION FOR URBAN AREAS,**
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 7B.
W82-03008

**RAINFALL CATCH ERRORS ASSOCIATED WITH CIRCUMAMBIENT OBSTRUCTIONS,**
West Virginia Univ., Morgantown.
E. W. Repa.
PhD Dissertation, 1981. 186 p, 33 Fig, 25 Tab, 40 Ref, 7 Append. University Microfilms International, Ann Arbor, MI; Order No GAX81-18414.

Descriptors: *Rainfall, *Rain gages, Rainfall distribution, Rainfall intensity, Measuring instruments, Circumambient obstruction.

Point measurements of rainfall are inherently inaccurate because of numerous and interacting observational. instrumental, and gage exposure errors. When openings in the forest canopy are made for the purpose of establishing a surface gaging station, rainfall distribution at ground level is not the same as it would have been at canopy level, and site related errors of additional unknown magnitude are introduced. The magnitude of these site errors has remained a matter of opinion because there is not any reliable experimental data from comparative observations in closely spaced forest openings of various dimensions. It was the purpose of this study to determine the effects of circumambient obstructions on rainfall catch. Results showed that gage catch was a function of screening angle, where the average maximum catch occurred at an angle of 26.57 deg. Rainfall catch decreased sharply as screening angles increased from 26.57 deg, and decreased slightly as screening angle decreases. Increased wind speeds, and decreased rainfall intensities, resulted in larger rainfall catch deficits especially for larger screening angles. Theoretical catch, as determined from Weiss' (1963) and Best's (1950) equations, was found to accurately predict actual catch except for very high intensities. (Sinha-OEIS)
W82-03021

**METEOROLOGY OF IMPORTANT RAINSTORMS IN THE COLORADO RIVER AND GREAT BASIN DRAINAGES,**
National Weather Service, Silver Spring, MD. Office of Hydrology.
E. M. Hansen, F. K. Schwarz, and J. T. Riedel.
National Oceanic and Atmospheric Administration Hydrometeorological Report No 50, December, 1981. 188 p, 121 Fig, 16 Tab, 53 Ref, 3 Append.

Descriptors: *Probable maximum precipitation, *Rainstorms, *Rainfall distribution, *Tropical cyclones, Atmospheric water, Rainfall intensity, Seasonal variation, Spatial distribution, *Meteorology, *Colorado River basin, *Great Basin.

Significant meteorological characteristics of storms, both general and local, and moisture sources that contribute to the understanding of extreme precipitation in the Colorado River and Great Basin drainages, and to the development of probable maximum precipitation (PMP) estimates were studied. A general storm produces significant precipitation over at least several hundred square miles and lasts at least a day. Significant general storms for this report can be classified into two groups: tropical storms, and extratropical storms. Based on general storms of record, it is considered that a hypothetical more extreme tropical cyclone could be the most extreme rain-producer over a larger portion of the southwestern states during August or September. The extratropical storms, in addition to being the controlling storm type for some portions of the Southwest, are also important for producing maximum precipitation in all areas of the Southwest for months other than those when tropical storms control. The general storm PMP for southwest Wyoming is most likely a storm with moisture from the Gulf of Mexico. A local storm is defined as unusually heavy rains exceeding 3.0 inches in 3.0 hr or less, that are reasonably isolated from surrounding rains. Terrain is considered to be a major factor in local storms in the Southwest, but mesoscale conditions leading to local storm PMP are likely to occur to some degree throughout the entire Southwest. Moisture availability and its geographic and seasonal distribution are important for PMP studies in this area. (Moore-SRC)
W82-03047

**LARGE RAIN DROPS IN THE BRIGHT BAND,**
Rome Air Development Center, Hanscom AFB, MA. Electromagnetic Sciences Div.
For primary bibliographic entry see Field 7B.
W82-03065

**WILL THE SAHELIAN DROUGHT END IN 1985,**
Centre National de la Recherche Scientifique, Marseille (France).
H. Faure, and J-Y. Gac.

Nature, Vol 291, No 5815, p 475-478, June 11, 1981. 4 Fig, 1 Tab, 29 Ref.

Descriptors: *Drought, *Rainfall, *Sahel region, Variability, Lake Chad, Senegal River, Weather patterns, Deserts, Arid regions, History, Geologic history, *Africa.

Analysis of rainfall variability in the Sahel region since the Quaternary period indicates a mean 31.3 year period between the last three droughts, with extreme conditions every 10.3 plus or minus 4 years. Extrapolating this data shows that the present drought should end in 1985, with a gradual return to maximum wet conditions about 1992. Another severe drought is likely about 2005. Data used for the background are variations in the levels of Lake Chad for the past 1,000 years, major famines and droughts for the past 300 years, and mean annual runoff and maximum height of the River Senegal at Bakel from 1903 to the present. (Cassar-FRC)
W82-03167

**RECIPROCATING HAIL PROCESSES IN THE ALPS,**
Consiglio Nazionale delle Ricerche, Rome (Italy). Inst. for Aerosol Nucleation.
H. M. Papee, G. L. Petriconi, and P. Ferrari.
Water, Air, and Soil Pollution, Vol 16, No 1, p 115-122, July, 1981. 4 Fig, 5 Ref.

Descriptors: *Hail, *Air pollution effects, *Thermal pollution, Statistical analysis, Precipitation, Storms, Agriculture, *Alps, *Italy.

Precipitation patterns in the Alps have demonstrated an inverse correlation between some adverse weather events which occurred in two adjacent zones. The possible effects of air pollution and thermal pollution on the weather in this area are discussed, and a model is proposed which fits the available data on agricultural losses due to hail in the Bolzano and Trento Provinces. The model makes many assumptions, including the assumption that Trento's loss is inversely proportional to Bolzano's. Also, it is assumed that surface hail effects in Trento are proportional to an exponential of the intensity of the storm which is directly proportional to the losses sustained by both Provinces or to the territory affected. While the model is simple, correlations obtained for all parameters were highly significant. More research is needed to establish precipitation anomalies due to a boom in industrialization and urbanization. (Small-FRC)
W82-03227

**THE RELATIONSHIP BETWEEN TOTAL PRECIPITABLE WATER AND SURFACE DEW POINT,**
Instituto de Pesquisas Espaciais, Sao Paulo (Brazil).
Y. Viswanadham.
Journal of Applied Meteorology, Vol 20, No 1, p 3-8, January, 1981. 8 Tab, 15 Ref.

Descriptors: *Atmospheric water, *Estimating equations, *Dewpoint, Water vapor, Precipitation, Probable maximum precipitation, Correlation analysis, *Southern hemisphere.

A method is provided for estimating the large-scale distribution of Southern Hemisphere atmospheric water vapor that is comparable to one previously developed for Northern Hemisphere data. Mean monthly and annual values of total precipitable water were compared with similar values of surface dew point for each 5 deg latitude circle from the equator to 85 deg S. The correlation coefficients were always positive but widely variable (0.21-0.99). The estimates of precipitable water from mean monthly surface dew-point temperature were not sufficiently reliable to justify making surface measurements to infer existing precipitable water. For some areas and seasons, large errors were found. Thus, the predicting equation has no value for those stations where a significant correlation does not exist between the two variables. There is no satisfactory substitute for direct measurement, and much more data collection is needed in the Southern Hemisphere. (Small-FRC)
W82-03257

**QUANTIFICATION OF RAINFALL AND ITS UTILIZATION EFFICIENCY IN RAJASTHAN,**
Central Arid Zone Research Inst., Jodhpur (India).
H. S. Mann, B. V. Ramana Rao, and G. G. S. N. Rao.
Journal of Arid Environments, Vol 4, No 2, p 107-113, June, 1981. 3 Fig, 6 Tab, 8 Ref.

Descriptors: *Water use efficiency, *Arid lands, *Water requirements, Rainfall-runoff relationships, Agriculture, *Rajasthan, *India, Semiarid lands, Runoff.

Rainfall utilization efficiency averaged 52.3% for Rajasthan, India, an arid to semi-arid region. Efficiency was low (< 30%) in the arid districts with low and erratic rainfall and 30-50% in semi-arid districts with unbalanced land use. The total amount of water not used for productive purposes in Rajasthan was 64055.76 million cu meters per year. The theoretical crop yield if all this water used is 3.71 million metric tons of pearl millet. These figures were obtained by adding the water requirements for livestock, humans, crops and vegetation, water lost through runoff and deep drainage, and subtracting from annual rainfall, 154168.64 million cu meters. Average annual flow of rivers in the region is 20505 million cu meters. (Cassar-FRC)
W82-03276

**DEW FALL IN THE DRY CLIMATIC ZONES OF INDIA,**
Andhra Univ., Waltair (India). Dept. of Meteorology and Oceanography.
A. R. Subramaniam, and A. V. R. K. Rao.
Journal of Arid Environments, Vol 4, No 2, p 103-106, June, 1981. 3 Fig, 1 Tab, 3 Ref.

Descriptors: *Dew, *Arid regions, *India, Precipitation, Rainfall, Seasonal variation, *Humid areas, *Semiarid climates, Comparison studies, Meteorological data collection.

Dew fall, an important meteorological factor in dry regions, was studied at six stations throughout India (in arid, semi-arid, and dry sub-humid areas). Measurements were recorded at four heights (5, 25, 50, and 100 cm). Maximum dew fall at Bikaner (humid), Arogyavaram (semi-arid), and Raipur (dry sub-humid) was in November-December; for Bellary (arid), September; Kota (arid), October; and Surat (sub-humid), October and February. Mean monthly dew falls during the dew season were: Bellary, 4.7 mm; Arogyavaram, 10.4 mm; and Raipur, 23.2 mm. At these 3 stations more than 80% of total dew fell from November to January, and the maximum amount of dew was deposited at the 100 cm height. During 1975-76 no rain fell during the dew season at Raipur; dew fall, the sole source of moisture, was 106% of normal rainfall. (Cassar-FRC)
W82-03278

**ACID PRECIPITATION IN THE PITTSBURGH, PENNSYLVANIA AREA,**
Pittsburgh Univ., PA. School of Public Health.
A. Roffman.
Journal of Environmental Sciences, Vol 23, No 2, p 33-37, March, 1980. 1 Tab, 1 Fig, 24 Ref.

Descriptors: *Acid rain, *Rainfall, *Air pollution, *Hydrogen ion concentration, *Lakes, Precipitation, Atmosphere, sulfuric acid, Nitrogen, Fertilizers, Ecosystems, International commissions, Organizations, Fish populations, Coniferous forests.

A survey of the pH levels of precipitation in the Pittsburgh area was conducted. Supplementary climatological data was collected. Results indicate that the pH values of samples in pollution-free areas were lower than those obtained at polluted stations. The industrial mills along the principal rivers seem to have had little or no effect on the pH values measured. The coal-burning power plants appear to have influnced the pH of precipitation. The data imply that pollution-carrying winds from the Ohio River Valley Basin contribute acidity to the stations. (Titus-FRC)
W82-03368

## 2C. Snow, Ice, and Frost

**FLOW CHARACTERISTICS BELOW FLOATING COVERS WITH APPLICATION TO ICE JAMS,**
Iowa Univ., Iowa City.
M. Gogus.
PhD Thesis, December, 1980. 186 p, 47 Fig, 1 Tab, 38 Ref, 2 Append. University Microfilms International, Ann Arbor, MI; Order No GAX81-14257.

Descriptors: *Flow characteristics, *Ice jams, Mathematical models, Rivers, Interfaces, Friction, Roughness coefficient, Model studies.

Mathematical models for wide-river jams have been developed. Besides two mechanisms (i.e., floe submergence and partial collapse) for the control of the jam equilibrium thickness, there is a third one - instability of floes along the jam underside. This flow instability phenomenon was the subject of a laboratory investigation, the results of which are presented in the first part of this study. The second part of the study is concerned with the characteristics of flow between boundaries of different roughness, with the upper one floating at the surface of an otherwise open channel, and focuses on the effect of one boundary on the friction characteristic of the other. Jam calculations must include computation of the resulting backwater curve, and require estimates of the shear stresses exerted both on the channel bed and on the jam underside. The goals of the study on flow characteristics between boundaries of different roughness is two-fold: to investigate the interaction between boundaries as far as the friction factor is concerned; and to devise a procedure for estimating the friction parameters at both boundaries for given flow conditions and roughness characteristics. (Sinha-OEIS)
W82-03011

**USE OF ENVIRONMENTAL SATELLITE DATA FOR INPUT TO ENERGY BALANCE SNOWMELT MODELS,**
California Univ., Santa Barbara. Computer Systems Lab.
For primary bibliographic entry see Field 7B.
W82-03048

**ON ANTARCTIC GLACIOLOGY: ICE SHEETS--AND ICE CORES,**
Northwestern Univ., Evanston, IL.
J. Weertman, and D. A. Peel.
Nature (London), Vol 294, No 5838, p 210-212, November 19, 1981. 2 Fig.

Descriptors: *Ice, *Chemical analysis, Carbon dioxide, Nitrates, Polar regions, *Antarctic, Glaciology, Cryology, Sulfates.

At the International Symposium on Antarctic glaciology, results were reported from research projects concerned with virtually all parts of the Antarctic continent, in oceanic islands neaar the continent, and on sea ice that surrounds it. The topography of the Antarctic ice sheets has been partially surveyed from satellites, by seismic sounding and by radar sounding. The symposium opened with sessions addressed to the problem of ice sheet stability. Other research was directed toward the effects of a carbon dioxide buildup and whether it will make the Antarctic ice more or less stable. Carbon dioxide concentrations in the air were lower during the last ice age than they are now. The major impurity of Antarctic ice is sulfate, and the mechanism by which it reaches the region is not yet fully explained. Difficulties are also being presented by the presence of nitrates in the ice. Elevated nitrate-nitrogen levels appear to coincide with years of solar flare activity peaks which are associaed with high auroral activity. Pronounced seasonal variations with maxima in winter months could be due to summer photochemical destruction of much of the nitrates. (Baker-FRC)
W82-03170

**THEORY OF THE DIELECTRIC CONSTANT OF ICE,**

Southampton Univ. (England). Dept. of Chemistry.
D. J. Adams.
Nature (London), Vol 293, No 5832, p 447-449, October 8, 1981. 1 Fig, 1 Tab, 19 Ref.

Descriptors: *Electrical properties, *Ice, Water, Physical properties, Mathematical studies, Mathematical models, *Model studies, *Comparison studies.

The theory of the dielectric constant of ice is discussed and a resolution of the internal field problem is proposed. Two rival theorteical expressions for the dielectric constant in terms of the dipole moment deal with different physical situations. The theory proposed here is that the correlations found in the perfect ice-rules model are to a good approximation the same as those that long-range dipole-dipole interactions will produce. It is demonstrated that the Fowler-Pauling ice-rules model of ice behaves like a dielectric material; matching the results of calculations on this model to experiment gives a dipole moment of 3.0 D. (Small-FRC)
W82-03176

**SOME BASIC EXPERIMENTS WITH A VERTICALLY-INTEGRATED ICE SHEET MODEL,**
Royal Netherlands Meteorological Inst. De Bilt.
J. Oerlemans.
Tellus, Vol 33, p 1-11, 1981. 12 Fig, 1 Tab, 17 Ref.

Descriptors: *Ice, *Actic, *Model studies, Glaciers, Climates, *Climatology.

Large scale behavior of ice sheets is investigated, as it is immediately relevant from the viewpoint of dynamic climatology. A simple 1 1/2 dimensional continental ice sheet model is presented, using as a basis Nye's proposal to express the vertical mean horizontal ice velocity. The results are theoretical; real case studies have yet to be carried out. The findings give insight into the effects of geometry and orography which can be applied to real situations. The diffusivity increases with both ice thickness and surface slope. Using various boundary conditions and parameterization of the annual mass balance, a series of experiments was carried out. It appeared that the boundedness of continents and bedrock elevations created a strongly nonlinear response of ice sheets to climatic variations. The behavior of Northern Hemisphere ice sheets as computed with the numerical model is compared to that predicted by a perfect-plasticity model. Including bedrock sinking in a simple way reveals that this causes Northern Hemisphere ice sheets to dissappear spontaneously within 15,000 years, after about 50,000 years of growth, initiated by a cold period. (Baker-FRC)
W82-03209

**WEST ANTARCTIC ICE SHEET FLUCTUATIONS IN THE ANTARCTIC PENINSULA AREA,**
Aberdeen Univ. (Scotland). Dept. of Geography.
D. E. Sugden, and C. M. Clapperton.
Nature (London), Vol 286, No 5771, p 378--381, July 24, 1980. 3 Fig, 17 Ref.

Descriptors: *Antarctic, *Glacial drift, *Geomorphology, Glaciers, Polar regions, Ice formation, Moraines, Prediction, *West Antarctic ice sheet.

Previous studies have concluded that the West Antarctic ice sheet is inherently unstable since much of it is grounded below sea level. It has been suggested that the ice sheet has withdrawn from its late Wisconsin maximum position, grounded at the edge of the continental shelf, and is currently undergoing collapse as a delayed response to the warming trend and rising sea levels of the Holocene. Rising carbon dioxide levels in the atmosphere are seen as likely to cause the ice sheet to collapse in the near future. A variety of geomorphologic evidence from Alexander Island and the Antarctic Peninsula does not support either of these hypotheses. Examination of moraines on the island and peninsula indicate that there was less ice on Alexander Island and the Antarctic Peninsula following the Wisconsin maximum about 8,000 years ago than there is now. The ice shelf in George VI Sound, which lies between these two bodies of land, has built up subsequent to this period. These findings indicate that the ice sheet has expanded during the last 8,000 years and that the West Antarctic ice sheet is able to survive without the presence of the George VI ice shelf. There is no reason to fear imminent collapse of the West Antarctic ice sheet due to climatic warming as long as the ice shelf survives. (Carroll-FRC)
W82-03362

## 2D. Evaporation and Transpiration

**OPERATIONAL ESTIMATES OF LAKE SUPERIOR EVAPORATION BASED ON IFYGL FINDINGS,**
National Oceanic and Atmospheric Administration, Ann Arbor, MI. Great Lakes Environmental Research Lab.
J. A. Derecki.
Water Resources Research, Vol 17, No 5, p 1453-1462, October, 1981. 4 Fig, 8 Tab, 16 Ref.

Descriptors: Lakes, *Evaporation, *Lake evaporation, *Lake Superior, Great Lakes, Water loss, Mass transfer, Estimating.

This paper tests the findings of studies of the International Field Year for the Great Lakes (IFYGL) on evaporation in Lake Superior and describes an improved mass transfer technique, based on atmospheric stability considerations, that can be applied to any large lake in different climatic conditions. Due to the extensive ice cover on Lake Superior during winter, the method includes ice cover reduction of standard overwater mass transfer evaporation to indicate actual winter evaporation from the lake. Method improvements consist of refinements in the mass transfer coefficient and the land-to-lake data adjustments derived from extensive investigations. Mass transfer evaporation estimates were verified by the water budget determinations, which for Lake Superior offer firm estimates of evaporation but are impractical for operational applications because of the long delays which occur in the availability of data. All hydrologic components of the Lake Superior water budget were of the same order of magnitude, with comparable errors, eliminating the possibility of large residual errors in computed evaporation. Evaporation values as determined by the two methods agree reasonably well for both seasonal distribution and the annual total, with a resulting long term annual value of approximately 500 mm. The ice cover adjustment reduced the average annual mass transfer overwater evaporation by 13% and produced much better agreement with the water budget seasonal distributions and annual values. In general the ice cover reduction of evaporation could be estimated by reducing the lake area by appropriate ice cover. (Baker-FRC)
W82-03074

**EVAPORATION FROM VEGETATION IN LANDSCAPES DEVELOPING SECONDARY SALINITY USING THE VENTILATED CHAMBER TECHNIQUE, III. EVAPORATION FROM A PINUS RADIATA TREE AND THE SURROUNDING PASTURE IN AN AGROFORESTRY PLANTATION,**
Commonwealth Scientific and Industrial Research Organization, Wembley (Australia). Div. of Land Resources Management.
E. A. N. Greenwood, J. D. Beresford, and J. R. Bartle.
Journal of Hydrology, Vol 50, No 1/3, p 155-166, March, 1981. 5 Fig, 2 Tab, 8 Ref.

Descriptors: *Evaporation, *Soil-water-plant relationships, *Trees, Evapotranspiration, Transpiration, *Pinus radiata, Pastures.

Evaporation was measured one day a month over 14 months on a 16 meter Pinus radiata tree enclosed in a ventilated chamber and on underlying pasture enclosed in a horizontal chamber. Evaporation from the tree ranged from 10 liters per day (0.6 mm per day) in April, May, and June to 170 liters per day (3.3 mm per day) in September. The pasture evaporation ranged from zero during the dry season to 1.4 mm per day in October. Xylem pressure potentials, measured on the enclosed tree and a nearby tree, were always within 1 bar of each other, limiting transpiration during the 6 month dry season. (Cassar-FRC)
W82-03213

**THE INFLUENCE OF PLANT WATER STRESS ON STOMATAL CONTROL OF GAS EXCHANGE AT DIFFERENT LEVELS OF ATMOSPHERIC HUMIDITY,**
Lancaster Univ., Bailrigg (England). Dept. of Biological Sciences.
O. Osonubi, and W. J. Davies.
Oecologia, Vol 46, No 1, p 1-6, July, 1980. 5 Fig, 27 Ref.

Descriptors: *Soil-water-plant relationships, *Stomatal transpiration, *Water stress, Transpiration, Birch, Gmelina, Plant water potential, Drought, Vapor pressure, Humidity.

The influence of plant water stress on stomatal humidity responses of two woody species was studied. Leaves of well-watered and mildly water stressed seedlings of birch (Betula pendula Roth) and Gmelina aroborea L. were subjected to vapor pressure deficits between 10 and 24 kPa. An increase in vapor pressure deficit in mildly stressed birch plants decreased stomatal conductance, maintained bulk leaf turgor, and increased efficiency of water use. Stomatal conductance of Gmelina seedlings, well watered or mildly stressed, showed no significant change when humidity of the air was varied. In Gmelina water use efficiency was high when stomata were open. Stomata of Gmelina seedlings began closing at a water potential of -1.0 MPa; birch, at -1.4 MPa. Closure was complete in Gmelina at -1.5 MPa and in birch at -1.8 MPa. Under conditions of water stress, growth of Gmelina is markedly reduced, but birch is capable of some growth under mild drought. (Cassar-FRC)
W82-03272

## 2E. Streamflow and Runoff

**A MODEL OF DISCONTINUOUS MEASUREMENT ERROR AND ITS EFFECTS ON THE PROBABILITY DISTRIBUTION OF FLOOD DISCHARGE MEASUREMENTS,**
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
K. W. Potter, and J. F. Walker.
Water Resources Research, Vol 17, No 5, p 1505-1509, October, 1981. 3 Fig, 15 Ref.

Descriptors: *Model studies, *Error analysis, Floods, Errors, Flood frequency, *Flood discharge, Flood forecasting, Mathematical models, *Flow rates.

In this paper a very simple model of discontinuous measurement error (dme) is developed and used to demonstrate that as a result of dme the probability distribution of measured floods can be greatly distorted with respect to the parent population. In particular, the population coefficients of variation, skewness, and kurtosis of the measured discharges can be significantly higher than the corresponding population coefficients of the actual flood discharges. This can be extremely important in flood frequency analysis. (Baker-FRC)
W82-03076

**PROGRAMMING MANUAL FOR MOBED - AN UNSTEADY, NONUNIFORM, MOBILE BOUNDARY FLOW MODEL,**
Canada Center for Inland Waters, Burlington (Ontario).
B. G. Krishnappan.
1981. 107 p, 22 Fig, 5 Tab, 3 Append.

Descriptors: *Sediment transport, *Mathematical models, *Unsteady flow, *Uniform flow, Hydraulic models, Manuals, MOBED, Hydraulic structures, Sediments, Dredging, Input data cards, *Channel flow.

In this manual, a mathematical model to predict the unsteady flow characteristics in mobile boundary channel flows (MOBED) is described. This manual is intended for potential users of this model and it contains descriptions of the underlying theory, numerical technique, program structure, input data requirement and format, model listing and an example of the model application. The model MOBED can be used for predicting both the short and long term effects of changes to the regime of a natural stream imposed by man and/or nature and hence could form a useful tool in the field of water resource management. (WATDOC)
W82-03109

**A PERSPECTIVE STUDY OF DROUGHTS IN MEXICO,**
National Water Planning Commission, Mexico City.
J. Sancho, and D. Perez Gavilan.
Journal of Hydrology, Vol 51, No 1/4, p 41-55, May, 1981. 4 Fig, 12 Ref.

Descriptors: *Drought, *Agriculture, History, Statistical analysis, Social aspects, Social impact, Economic aspects, *Mexico.

A historic study was conducted to outline the manifestations and consequences of droughts during the entire history of Mexico, followed by a statistical analysis to investigate the extent, duration, frequency and magnitude of droughts in that country. Historically, droughts affected not only the health of the people, but their economic and social structures as well. In every case of poor harvests and rising costs of basic foods, the consequences of the natural phenomena were aggravated by social factors. Scarcity and high costs were increased by speculation and market monopolies. Large migratory movements occurred. The partial or total suspension of non-agricultural activities such as mining, manufacturing and textile crafts, along with migration and unemployment, increased criminality and social tensions. The statistical analysis has yielded some inferences about drought behavior, although it is still not possible to predict the occurrence of a drought on an annual or seasonal basis. A base network of 157 rainfall gauging stations was established throughout the country, and a minimum of twenty years of records were maintained. The variability of precipitation was found to be a good indicator of drought risk; the greater the risk, the greater the variability. It was observed that different percentages of normal precipitation were recorded for 1, 2, 3 or 5 continuous years at each station. Curves were constructed for the entire country which define the characteristics of extent, magnitude, duration and frequency of precipitation deficiency. Varying intensity classifications were able to be applied to droughts occuring over the past 40 yr. (Baker-FRC)
W82-03358

**COMMUNICATION ON 'VARIATION OF MANNING'S N ROUGHNESS COEFFICIENT WITH FLOW IN OPEN RIVER CHANNELS'.**
Journal of the Institution of Water Engineers and Scientists, Vol 35, No 1, p 94-95, January, 1981.

Descriptors: *Mannings equation, *Roughness coefficient, *Streamflow, Sediment transport, Channel morphology, Flows, Rivers, *Open-channel flow.

A paper by Sargent on variation of Manning's n computed for five gaging stations on 5 different rivers showed substantial increase in n at low stages and a smaller constant value at higher stages at bankfull conditions were approached. The author recommended extending gaging station calibration curves beyond the highest measured level for flow contained within the channel banks. These conclusions aroused several comments that their value would be enhanced by considering changes in channel shape, sediment transport, and bed configuration changes. (Cassar-FRC)
W82-03382

## 2F. Groundwater

**THE MADRID BASIN AQUIFER: PRELIMINARY ISOTOPIC RECONNAISSANCE,**
Madrid Univ. (Spain). Dept. of Geology and Geochemistry.
F. L. Vera, J. C. Lerman, and A. B. Muller.
Journal of Hydrology, Vol 54, No 1-3, p 151-166, December, 1981. 5 Fig, 6 Tab, 23 Ref.

Descriptors: *Aquifers, *Isotopic tracers, *Model studies, *Flow profiles, *Groundwater dating, Groundwater movement, Isotope studies, Carbon, Oxygen, Flow pattern, Radioisotopes, Water analysis, Groundwater basins, Groundwater recharge, Geohydrology, *Madrid Basin aquifer, Spain.

C and O isotopic studies were carried out on the Madrid Basin aquifer to corroborate a three-dimensional groundwater flow model of this groundwater system. Results showed that both recharge and discharge have sigma-values close enough to indicate that climatic conditions of the basin have been relatively stable. Local analyses done by aquifer tests showed that hydraulic conductivities calculated from the radiocarbon ages are of the correct order of magnitude. No evidence was found to support the previous hypothesis of large regional flow. On the contrary, the radiocarbon ages of the waters in the wells analyzed seem to support the existence of local flow in the Madrid aquifer. Other factors such as carbon precipitation or dilution and subsurface radiocarbon production which might influence the radiocarbon ages are also being studied. (Geiger-FRC)
W82-03059

**NUMERICAL STABILITY AND ACCURACY OF IMPLICIT INTEGRATION OF FREE SURFACE GROUNDWATER EQUATIONS,**
Cornell Univ., Ithaca, NY.
P. L-F. Liu, and J. A. Liggett.
Water Resources Research, Vol 16, No 5, p 897-900, October, 1980. 7 fig, 4 Ref.

Descriptors: *Darcys Law, *Laplace equation, *Mathematical studies, *Flow, *Groundwater, Algorithms, Numerical analysis, Fourier analysis, Finite difference equation, *Groundwater movement, Porous media.

In the solution of two- or three-dimensional free surface flow the time-dependent boundary condition is represented in an implicit finite difference form. The numerical solution may damp or amplify the real solution or contain oscillations, either stable or unstable, about the real solution, depending on the weighting factor and the wave number of the solution mode. Zero numerical damping occurs when the weighting factor has a value between 0.5 and 0.6. The exact value depends on the wave number and length of the time step. The weighting factor and time step are chosen by performing stability analysis on a linearized system of equations and extrapolating the results to the nonlinear system. (Titus-FRC)
W82-03060

**A NUMERICAL METHOD FOR THE CALCULATION OF THE AVERAGE DRAWDOWN IN A FULLY PENETRATING OBSERVATION WELL IN AN UNCONFINED AQUIFER,**
Council for Scientific and Industrial Research, Pretoria (South Africa).
L. Rolfes.
Water Resources Research, Vol 16, No 5, p 887-890, October, 1980. 2 Tab, 4 Ref.

Descriptors: *Aquifers, *Drawdown, *Unconfined aquifers, *Permeability, *Numerical analysis, Mathematical methods, Computer applications, Computer models, Algorithms, Wells, Observation wells.

A numerical method which is numerically stable and makes use of a convergence acceleration algorithm is proposed for the calculation of Neuman's formula for the average drawdown in an observation well completely penetrating an unconfined aquifer. The unconfined aquifer integral was evaluated for various values of three parameters, and results were compared with those of the Neumann method in terms of accuracy and computer execution time. The results of both methods are comparable in accuracy, but the proposed method requires less computer time. (Titus-FRC)
W82-03061

**MODELING DOUBLE AQUIFER FLOW USING A COMPREHENSIVE POTENTIAL AND DISTRIBUTED SINGULARITIES 1. SOLUTION FOR HOMOGENEOUS PERMEABILITY,**
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
O. D. L. Strack, and H. M. Haitjema.
Water Resources Research, Vol 17, No 5, p 1535-1549, October, 1981. 17 Fig, 23 Ref.

Descriptors: *Model studies, *Permeability, Aquifers, Aquifer characteristics, Flow, *Aquifer systems, Groundwater flow, *Groundwater movement.

A technique is presented for modeling two-dimensional horizontal flow in a system of two infinite aquifers. The technique proposed is based upon the use of line sinks for incorporating creeks, lake boundaries, rivers, and canals into the model. The potentials for the elements are used as functions of a complex variable and are Cauchy integrals along finite line elements of the type discussed by Muskelishvili. The method is incorporated into the computer program SYLENS (steady flow with a lens) that is used to model a system of two aquifers divided by a thin impervious bed and hydraulically connected through the openings in the separating layer. The analysis in this paper is restricted to the case that the permeabilities in the two aquifers may be different from each other but do not vary with position. The aquifers are separated by a thin impermeable layer and are hydraulically connected through openings in the separating bed. The upper aquifer is unconfined, and the flow in the lower aquifer is confined in some regions and unconfined in others. The method is validated against various exact solutions, and some examples of applications of the method are discussed. (Baker-FRC)
W82-03078

**BIEM SOLUTIONS TO COMBINATIONS OF LEAKY, LAYERED, CONFINED, UNCONFINED, NONISOTROPIC AQUIFERS,**
Cornell Univ., Ithaca, NY. School of Civil and Environmental Engineering.
O. E. Lage, J. A. Liggett, and P. L-F. Liu.
Water Resources Research, Vol 17, No 5, p 1431-1444, October, 1981. 17 Fig, 1 Tab, 16 Ref.

Descriptors: *Aquifers, *Mathematical models, Model studies, Water table aquifers, *Aquifer characteristics, Leaky aquifers, Layered aquifers, *Groundwater movement, Aquifer systems, Confined aquifer, Unconfined aquifers, Nonisotropic aquifers.

A study was made to develop a program which could solve a variety of groundwater problems, including many of the complexities found in actual aquifers, while retaining insofar as possible the advantages of the boundary integral equation method (BIEM). In complex aquifers it is necessary to solve nonlinear equations and equations with nonconstant coefficients. The nonhomogeneous equations are solved by use of efficient and automatic area integrations. Matrix substructuring is used to decrease computer requirements for large, complex problems and also to maintain efficiency. Solutions in leaky, layered aquifers are found by iteration. Thus the advantages of the BIEM are available for the solution of complex systems. In the calculations presented here the effective dimension of an aquifer system is reduced to two by the use of the Dupuit assumption. The BIEM further reduces the computational dimension by one. Thus a three-dimensional problem is solvable by line integration. An additional major advantage of the BIEM method is the ease of data preparation in that the analyst needs to supply a minimum of data. The total storage requirements for the BIEM are also less than they would be for

domain methods. The program may thus be more available for use on small computing systems. (Baker-FRC)
W82-03079

**ON THE COMPUTATION OF DARCIAN VELOCITY AND MASS BALANCE IN THE FINITE ELEMENT MODELING OF GROUNDWATER FLOW,**
Oak Ridge National Lab., TN. Environmental Sciences Div.
G-T. Yeh.
Water Resources Research, Vol 17, No 5, p 1529-1534, October, 1981. 8 Fig, 3 Tab, 10 Ref.

Descriptors: *Model studies, *Groundwater movement, Flow, Mathematical models, Darcy's law, Mathematical studies, *Finite element method, Velocity.

Darcian velocity has been conventionally calculated in the finite element modeling of groundwater flow by taking the derivatives of the computed pressure field. Since a continuous velocity field is required for the simulation of waste transport in the subsurface aquifer system, the conventional approach used in finite element modeling results in discontinuity of velocity at element boundaries and nodal points. It may also yield large errors in the overall mass balance computation. Thus it is necessary that the same finite element method which is employed to simulate the pressure field be applied to Darcy's law to obtain the velocity field. This will ensure a continuous velocity field and greatly reduce the overall mass balance error. The central difference Galerkin scheme yields the lowest error, as the governing equation is basically of the Laplacian type in spatial coordinates. It is proposed in this paper that the finite element procedure that is used to simulate the pressure field or the moisture content field also be applied to Darcy's law with the derivatives of the computed pressure field as the load function, thus eliminating the problem of discontinuity. (Baker-FRC)
W82-03083

**MODELING DOUBLE AQUIFER FLOW USING A COMPREHENSIVE POTENTIAL AND DISTRIBUTED SINGULARITIES 2, SOLUTION FOR INHOMOGENEOUS PERMEABILITIES,**
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
O. D. L. Strack, and H. M. Haitjema.
Water Resources Research, Vol 17, No 5, p 1551-1560, October, 1981. 15 Fig, 25 Ref.

Descriptors: *Model studies, *Permeability, *Aquifer characteristics, Aquifers, Flow, *Groundwater movement.

A technique is presented for modeling two-dimensional horizontal flow in a system of two infinite aquifers. In this paper the technique is generalized to the case of inhomogeneous permeabilities. The aquifer is subdivided into regions of homogeneous permeability, with discontinuities of the permeability occurring across the boundaries of these regions. The potentials are discontinuous across the common boundaries, which are represented as polygons. Line doublets are used to create the discontinuities in the potentials without violating the condition of continuity of flow. The strengths of the line doublets are determined from the condition that the head is continuous across the boundaries of the subregions. The method is validated against exact solutions, and some applications are considered. The modeling of inhomogeneous situations by the use of line doublets is presented for a Dupuit-Forchheimer analysis, but is equally well applied to problems of three-dimensional flow and two-dimensional flow in the vertical plane. The potential to be used for the latter applications equals the permeability times the head. (Baker-FRC)
W82-03084

**VERIFICATION OF THE POTENTIAL YIELD AND CHEMICAL QUALITY OF THE SHALLOW DOLOMITE AQUIFER IN DUPAGE COUNTY, ILLINOIS,**
Illinois State Water Survey Div., Champaign.
R. T. Sasman, R. J. Schicht, J. P. Gibb, M. O'Hearn, and C. R. Benson.
Circular 149, 1981. 46 p, 26 Fig, 1 Tab, 10 Ref.

Descriptors: *Aquifers, *Dolomite, Water level, Water yield, Groundwater, *Potential water supply, Groundwater depletion, Groundwater pollution, Dewatering, Piezometers, Pumping, Chemical properties, Dissolved solids, Hardness, Sulfate, Chlorides, Sodium, Iron, DuPage County, *Illinois.

As an alternative to pumping water from Lake Michigan, the Illinois Division of Water Resources looked to the dolomite aquifer in DuPage County. Data collected over a 700-square-mile area was used to analyze the impact of continually increasing pumpage, to locate existing and potential trouble areas, and to identify areas suitable for additional pumpage. From 1966 to 1978, pumpage in DuPage County increased 91 percent from 24 to 45.8 mgd; 95 percent of the 1978 shallow aquifer pumpage, 43.5 mgd, was from the dolomite. Estimates of the potential yield of these shallow aquifers is 44.4 mgd, so the 1978 pumpage of 45.8 mgd was 103 percent of the total. Because of the heavy pumpage, water levels have lowered considerably and major sections of the aquifer system have been dewatered. The decline in water levels has resulted in their being lowered below the bedrock surface over about 9.5 square miles of DuPage County since 1966. If pumpage continues at the 1978 ratio, shallow aquifer pumpage would be about 63 mgd by the year 2000, and would cause major decreases in yields in wells and well fields countywide. The study also showed that the highest chemical concentrations in the aquifer are generally found in areas with the greatest development of aquifer pumpage and of the overlying land surface. Concentrations of total dissolved solids, hardness, sulfate, chloride, sodium, and total iron in samples from the area are quite high. Periodic studies are recommended to assess water quality programs and to keep abreast of the chemical state of the groundwater from this aquifer. (Atkins-Omniplan)
W82-03100

**SALT-WATER INTRUSION IN A LAYERED COASTAL AQUIFER AT YORK POINT, PRINCE EDWARD ISLAND,**
National Hydrology Research Inst., Ottawa (Ontario).
G. van der Kamp.
NHRI Paper No 14, IWD Scientific Series No 121, 11 p, 1981. 21 Ref, 8 Fig, 2 Tab.

Descriptors: *Water levels, *Salinity, Measurements, *Coastal aquifers, Brackish water, Freshwater, Tidal fluctuations, Hydrology, Intrusion patterns, North River Estuary, Prince Edward Island, Canada, *Saline water intrusion, Aquifers, Groundwater movement.

Detailed measurements of water levels and salinities have been carried out in a layered coastal aquifer, undisturbed by pumping, at York Point, Prince Edward Island. The position and movements of the sea water in the aquifer are analyzed in relation to density differences, and tidal, seasonal and secular changes of water levels. Separate 'wedges' of salt water were encountered in each permeable layer. In the deeper beds, fresh water has been encountered in association with anomalously low heads. This phenomenon is at least in part due to the entrainment of salt water by the seaward flow of fresh water, but the rising sea level in the area can also lead to such an effect and, in fact, may have an important bearing on the pattern of salt-water intrusion at depth. (WATDOC)
W82-03108

**FINAL REPORT, GROUND WATER STUDY, AMES-CAMBRIDGE REACH OF THE SKUNK RIVER, STORY COUNTY, IOWA,**
Iowa State Water Resources Research Inst., Ames.
M. D. Dougal.
ISWRRI-119, June, 1980. 58 p. 13 Fig, 3 Tab, 20 Ref, 3 Append.

Descriptors: *Groundwater movement, Water quality control, Data collections, *Groundwater potential, *Aquifers, Subsurface drainage, Groundwater pollution, Water table fluctuations, Land disposal, Wastewater disposal, *Water pollution control, Alternative planning, Well water.

A study of the downstream continuation of the Ames Buried Channel Aquifer from Ames to Cambridge, Iowa, was made to determine the movement of water in the flood plain area and to provide a preliminary evaluation of the potential impact of the new water pollution control plant on the community of Cambridge. Cambridge has ground water wells drilled into the buried channel aquifer. Three sites evaluated were found to be suitable as to potential impact on ground water and land suitability for disposal of digested sludge. Site 5, which consists of silts, clays, and clayey sands to a depth of 12 to 15 feet, remains the most isolated site and land disposal would affect the least number of persons and housing units. The surficial soil profile implies slow infiltration and good retention of soil moisture. The ground water levels at Cambridge are greater than the river level during normal or low flow periods, and future evaluation may be needed if increased well withdrawals reverse the positive riverward ground water gradient. One more costly alternative would be to continue the outfall five miles southward to a point about two miles south of Cambridge; however, that would require a regional scope to water quality control. Groundwater quality studies made at observation wells showed that the water quality in the aquifer is similar to that measured at Ames, and that the Buried Channel Aquifer is a valuable source of water supply. During flood periods the Ames River may cause more of a pressure wave effect and less of a water movement recharge phenomenon. If Site 5 is selected, several recommendations must be considered, such as flood protection and various monitoring programs. (Garrison-Omniplan)
W82-03112

**RECHARGE MECHANISMS AND GROUNDWATER FLOW IN THE CHALK AND DRIFT DEPOSITS OF SOUTHERN EAST ANGLIA,**
Birmingham Univ. (England). Dept. of Geological Sciences.
J. W. Lloyd, D. Harker, and R. A. Baxendale.
Quarterly Journal of Engineering Geology, Vol 14, No 2, p 87-96, 1981. 8 Fig, 5 Tab, 18 Ref.

Descriptors: *Aquifers, *Groundwater movement, *Groundwater recharge, Mathematical models, Geologic formations, Flow, Underground storage, Gravel, Anglian Water Authority, *England, Chalk deposits.

An extensive study of the hydrochemistry of groundwaters in the Chalk and drift deposits of southern East Anglia was carried out to obtain a qualitative understanding of the recharge and flow mechanisms operating in the two aquifer units. Five main water types were identified for the Chalk aquifer, and three drift environments were determined. These results were used to define a model of recharge and flow mechanisms. Recharge to the aquifer north of the London Clay boundary was concentrated along the major river valleys. Modern water containing nitrate was found only where the aquifer had a high permeability and where the flow is consequently high. Significant storage for the water abstracted from the Chalk aquifer was provided by the adjacent drift sands and gravels. South of the London Clay boundary, the drift acted as a storage reservoir and supplied an important base-flow component to the rivers. (Small-FRC)
W82-03182

**CARBON ISOTOPE FRACTIONATION DURING MICROBIAL METHANE OXIDATION,**
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
For primary bibliographic entry see Field 5A.
W82-03188

**A PROBLEM POSED BY VAPOUR-DOMINATED GEOTHERMAL SYSTEMS,**

California Univ., Los Angeles. Dept. of Earth Sciences.
For primary bibliographic entry see Field 1A.
W82-03200

**PROGRAMMABLE HAND CALCULATOR PROGRAMS FOR PUMPING AND INJECTION WELLS: III. CONSTANT PUMPING (INJECTION) RATE, FULLY CONFINED AQUIFER, PARTIALLY PENETRATING WELL,**
Missouri Univ.-Rolla.
D. L. Warner, and M. G. Yow.
Ground Water, Vol 18, No 5, p 438-443, September-October, 1980. 1 Fig, 1 Tab, 6 Ref.

Descriptors: *Computer programs, *Aquifers, Confined aquifers, Injection wells, *Wells, *Pressure head, Pumping head.

Two previous articles by the authors presented programmable hand calculator programs for calculation of head or pressure changes resulting from the pumping from or injection into wells completely penetrating fully confined and simiconfined aquifers. The appendices of this paper provide programs for the Texas Instrument TI 59 card programmable calculator to solve the same head or pressure changes in wells partially penetrating a fully confined aquifer or wells that fully penetrate, but are incomplete or partially screened. (Cassar-FRC)
W82-03225

**FLOW IN AQUIFERS WITH CLAY LAMINAE 2. EXACT SOLUTIONS,**
Minnesota Univ., Minneapolis. Dept. of Civil and Mineral Engineering.
O. D. L. Strack.
Water Resources Research, Vol 17, No 4, p 993-1004, August, 1981. 12 Fig, 6 Tab, 5 Ref.

Descriptors: *Error analysis, *Aquifers, *Impervious beds, *Steady flow, *Groundwater movement, *Clays, Laminar flow.

The method of determining steady flow in clay laminae-containing aquifers, developed in Part 1 of this work, is used to obtain approximate solutions of two cases. Exact solutions are also obtained, using standard complex variable techniques. The first case is confined flow in an aquifer system with an infinite lamina with a slot. The second is unconfined flow in an aquifer system with a semi-infinite lamina. In the first case there is significant error in discharge, up to plus or minus 25%. An acceptable error is found in the situation where boundary conditions are applied at distances of 15 times the aquifer thickness, or more, away from the slot. The error in the second example is less, maximum 12.7%, and may be explained by the differences in geometry. (Cassar-FRC)
W82-03232

**FLOW IN AQUIFERS WITH CLAY LAMINAE 1. THE COMPREHENSIVE POTENTIAL,**
Minnesota Univ., Minneapolis, Dept. of Civil and Mineral Engineering.
O. D. L. Strack.
Water Resources Research, Vol 17, No 4, p 985-992, August, 1981. 9 Fig, 10 Ref.

Descriptors: *Aquifers, *Steady flow, *Impervious beds, Groundwater movement, *Clays, Laminar flow, Groundwater potential, Comprehensive potential, Model studies, Permeability.

Steady flow of fresh water in an aquifer system containing thin impervious clay laminae is described. It is assumed that the laminae do not overlap. A steady state two-dimensional Dupuit-Forchheimer model predicts piezometric heads in the system. Conditions of confined, unconfined, confined interface, and unconfined interface flow may be considered in the aquifer above and below the laminae. A new potential (called the comprehensive potential) is introduced with a gradient equal to minus the vectorial sum of the discharges in the upper and lower aquifers. It is determined by solving a boundary value of the Poisson equation. Heads can be established along the edges of the clay lamina without using an iterative procedure. The analysis is applied to two cases, both involving two infinite aquifers separated by an infinite lamina. The aquifers are hydraulically connected through a circular opening in the lamina. No rainfall infiltration is present. In the first case, flows are unconfined, with a well in the lower aquifer and a recharge well in the upper. The second case has confined flows and no wells. To apply the analysis to multiple laminae the comprehensive potential technique is applied in steps, working to the innermost boundary. The method can be used when permeabilities in the upper and lower aquifers are different if the potentials in terms of heads are properly defined. (Cassar-FRC)
W82-03242

**MOLECULAR APPROACH TO THE FOUNDATIONS OF THE THEORY OF SOLUTE TRANSPORT IN POROUS MEDIA. I. CONSERVATIVE SOLUTES IN HOMOGENEOUS ISOTROPIC SATURATED MEDIA,**
Mississippi Univ., University. Dept. of Civil Engineering.
V. K. Gupta, R. N. Bhattacharya, and G. Sposito.
Journal of Hydrology, Vol 50, No 1/3, p 355-370, March, 1981. 22 Ref.

Descriptors: *Porous media, *Solute transport, *Diffusion coefficient, Model studies, Path of pollutants.

A molecular model is developed for the transport of low concentrations of a conservative solute in a homogeneous isotropic water-saturated porous medium. In this model, a solute molecule randomly collides with the solid grains in the medium and is scattered in a random direction. A parabolic differential equation for the solute concentration at the macroscopic level is derived from the molecular model. When solute connection is absent, the coefficient of molecular diffusion in a porous medium is less than the coefficient of molecular diffusion in bulk solution. For convection greater than zero the medium is assumed to be isotropic to prove that the solute dispersion tensor is diagonal. For small values of liquid velocity, the isotropicity assumption implies that the coefficients of longitudinal and transverse dispersion are approximately parabolic functions of the liquid velocity. Comparisons of derived dispersion coefficients with observed values suggest that solute-liquid molecular collisions, rather than solute molecules-solid phase grains collisions, account for the relationship between dispersion coefficients and liquid velocity. The solute convective velocity is less than or equal to the liquid velocity. (Cassar-FRC)
W82-03316

**ANALYSIS OF FLOW THROUGH HETEROGENEOUS RANDOM AQUIFERS BY THE METHOD OF EMBEDDING MATRIX. 1. STEADY FLOW,**
Tel-Aviv Univ. (Israel). School of Engineering.
G. Dagan.
Water Resources Research, Vol 17, No 1, p 107-121, February, 1981. 4 Fig, 19 Ref.

Descriptors: *Aquifers, *Flow, *Statistical models, Hydraulic conductivity, Non-uniform flow, Boundaries (Surfaces), Model studies, Hydrology, Monte Carlo method, Porous media, Earth-water interfaces, Mathematical models, *Groundwater movement, Aquifer characteristics.

This paper is a continuation and extension of Dagan's (1979) work on flow through aquifers whose properties vary in space in a random fashion. The statistical structures of the hydraulic conductivity, head gradient, specific discharge, and head fields are analyzed using a model consisting of a collection of spherical and cylindrical blocks with different conductivity and diameter, set randomly and independently in space. The influence of boundaries (regions not statistically homogeneous) and nonuniform average flows are analyzed for the first time. The growth of head variance with distance from the boundary in 2-dimensional flows is analyzed and compared with the Smith and Freeze (1979) Monte Carlo simulations. (Cassar-FRC)
W82-03320

**STUDIES ON THE SALINIZATION OF COASTAL GROUND WATER. I. CONFINED GROUND WATER IN THE NAKA RIVER ESTUARY (IN JAPANESE),**
Nara Coll. of Education (Japan). Dept. of Geoscience.
For primary bibliographic entry see Field 2L.
W82-03326

**FIRST ORDER ANALYSIS OF UNCERTAINTY IN NUMERICAL MODELS OF GROUNDWATER FLOW. PART I. MATHEMATICAL DEVELOPMENT,**
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
M. D. Dettinger, and J. L. Wilson.
Water Resources Research, Vol 17, No 1, p 149-161, February, 1981. 31 Ref, 3 Append.

Descriptors: *Groundwater movement, *Mathematical studies, *Model studies, Piezometry, Hydrology, Aquifers, Flow measurement.

Part 1 of this paper includes a discussion of the nature and sources of uncertainty encountered in groundwater flow models, especially numerical models. The models are cast in state-space form, with boundary conditions and inputs that are functionally dependent on, but statistically independent of, time. First and second order Taylor series expansions of the model equations are derived and used to estimate the mean and variance-covariance properties of piezometric head predictions, given corresponding statistics for aquifer parameters: material properties, initial conditions, boundary conditions, and inputs. The first order estimate of the piezometric head is identical to the deterministic result. Prediction uncertainty is a function of the magnitude of the parameter uncertainty and sensitivity of the predictions to the parameters. Part 2, to be presented later, will illustrate the effects of parameter uncertainty on predictions of heads for 1 and 2 dimensional aquifer flows. (Cassar-FRC)
W82-03329

## 2G. Water In Soils

**FORECASTING SUBSURFACE WATER FLOW AND STORAGE ON FORESTED SLOPES USING A FINITE-ELEMENT MODEL,**
M. Mohsenisaravi.
PhD Dissertation, January, 1981. 179 p, 39 Fig, 13 Tab, 151 Ref, 2 Append. University Microfilms International, Ann Arbor, MI; Order No GAX81-19892.

Descriptors: *Model studies, *Watershed management, *Forest watersheds, Storm seepage, Forecasting, Snowmelt, Permeability coefficient, *Idaho, Finite element method.

Subsurface flow in a three soil layer vertical cross section of the Pine Creek watershed in the Idaho Batholith of central Idaho was simulated using the finite element model, UNSAT2, under uncut, clearcut, and wildfire conditions. The model was based on a two-dimensional transient saturated-unsaturated analysis of the subsurface flow at the field site. The sensitivity of subsurface outflow to various input parameters indicated that subsurface outflow was most sensitive to the magnitude of saturated hydraulic conductivity. The simulations indicated that different snowmelt events require different saturated hydraulic conductivity to simulate subsurface outflow adequately. Nomographs were made showing the changes of saturated hydraulic conductivities on control and treated watersheds under harvesting and burning situations. (Sinha-OEIS)
W82-03018

**NODAL DOMAIN INTEGRATION MODEL OF UNSATURATED TWO-DIMENSIONAL SOIL-WATER FLOW: DEVELOPMENT,**

California Univ., Irvine. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W82-03080

**SOIL MORPHOLOGY AND PREFERENTIAL FLOW ALONG MACROPORES,**
Soil Survey Inst., Wageningen (Netherlands).
J. Bouma.
Agricultural Water Management, Vol 3, No 4, p 235-250, 1981. 6 Fig, 53 Ref.

Descriptors: *Soil structure, *Pores, *Morphology, *Soil water, Soil physics, Soil physical properties, Soil porosity, Macropores, Flow characteristics, Tracers, Infiltration, Hydraulic conductivity, Methylene blue, Clays.

Preferential flow in saturated soil involves rapid displacement of water from macropores; and in saturated soil, flow into air-filled macropores (short-circuiting), followed by lateral absorption. Macropores, defined as pores significantly larger than those which result from packing of individual soil particles, occur in three major forms: cylindrical channels, planes, and irregular. Macropores may be studied by several methods. Field descriptions are good only for identifying major differences in soils. Schematized structure models and use of stains such as methylene blue are useful in seeing infiltration into cracked soils. Pedological features such as mottling patterns can be used as indicators for preferential flow along macropores. Micromorphology measures the features very accurately, but results apply only to the thin sections studied; techniques are expensive. (Cassar-FRC)
W82-03175

**SOLUTION OF THE CONTINUITY EQUATION FOR THE KARNAK AREA,**
Toronto Univ. (Ontario). Dept. of Chemistry.
T. C. Billard, and G. Burns.
Nature (London), Vol 285, No 5767, p 654-655, June 26, 1980. 2 Fig, 1 Tab, 6 Ref.

Descriptors: *Saline soils, *Simulation analysis, *Continuity equation, Mathematical analysis, Mathematical equations, *Egypt, Nile River, Land management, Salinity, Soil water table, Irrigation, Soil water, Environmental effects.

A computer simulation of the flow of saline water in the area of the Great Temple of Karnak (Egypt) was devised to determine whether salinization presents a serious threat to the antiquities in that region. The physical system used in the simulation is represented by a river valley between two rows of mountains impermeable to water. The temples are situated in an unirrigated region between the river and an irrigated area. Water and soluble salts from the irrigated fields are driven into the river by the difference in the levels of the Nile and the water table under the irrigated fields. Since there is no irrigation in the temple area, the evaporation of moisture at the soil surface constitutes another driving force which moves saline water from the water table to the surface, where the salts are deposited. Solution of the steady-state continuity equation provides information on the relative importance and the approximate rates of these processes for the water saturated region. A computer program, which can be used on a mini-computer, was developed and yielded a solution for the equation which was stable, consistent, and convergent. The flow results, including the amounts of salt deposited in unirrigated areas, were found to be directly proportional to the hydraulic conductivity. The height of the water table was found to be the key boundary condition. About 92 percent of the water draining from the irrigated land is evaporated on or near the surface of the unirrigated land. These results indicate that new physiochemical processes operating since the Aswan Dam was built are causing salinization of land, endangering the foundations of the temples and unexcavated antiquities. (Carroll-FRC)
W82-03196

**FIELD APPLICATION OF THE FOUR-ELECTRODE TECHNIQUE FOR DETERMINING SOIL SOLUTION CONDUCTIVITY,**
Agricultural Research Organization, Bet-Dagan (Israel). Div. of Soil Physics.
A. Nadler.
Soil Science Society of America Journal, Vol 45, No 1, p 30-34, 1981. 6 Fig, 3 Tab, 12 Ref.

Descriptors: *Conductivity, *Soil solution, *Measurement techniques, Soil water, Calibrations, Salinity.

The four-electrode resistivity technique is used to obtain measurements of the in situ actual soil solution electrical conductivity by measuring bulk soil electrical conductivity. A procedure for determining the in situ soil solution conductivity from bulk soil electrical conductivity measurements is proposed. It comprises the preparation of calibration curves for soil solution and bulk soil conductivity in each soil under consideration using the electrical conductivity of the free draining solution instead of that of the soil solution extracts. The contributions of surface conductance to bulk soil electrical conductivity are calculated as a function of soil solution electrical conductivity using an iterative procedure. A correction factor is used that considers the relative soil volumetric water content rather than the absolute value in order to permit field measurements under a variety of soil moisture values. In situ electrical conductivity of a soil solution was calculated using the four-elctrode technique and this suggested calibration procedure, and the resultant values were compared to those for the electrical conductivity of soil solution extracts. The electrical conductivity of in situ soil solution calculated using this method was close to that of irrigation water and was always equal to or smaller than that estimated from the electrical conductivity of 1:1 soil extracts and back calculation to field water content. The electrical conductivity of soil surface ions may be greater than the electrical conductivity of soil solution ions, leading to unreasonable results when the electrical conductivity of surface ions is not properly considered. A commonly used soil extraction method for estimating soil solution electrical conductivity was shown to be highly influenced by total salt content and by soil moisture levels, emphasizing the advantages of the four-electrode method for measuring in situ soil water salinity. (Carroll-FRC)
W82-03260

**SOIL HYDRAULIC PROPERTIES AS STOCHASTIC PROCESSES: I. AN ANALYSIS OF FIELD SPATIAL VARIABILITY,**
Agricultural Research Organization, Volcani Center, Bet Dagan (Israel). Div. of Soil Physics.
D. Russo, and E. Bresler.
Soil Science Society of America Journal, Vol 45, No 4, p 682-687, July/August, 1981. 4 Fig, 2 Tab, 20 Ref.

Descriptors: *Soil properties, *Stochastic hydrology, *Permeability coefficient, Soil engineering, Stochastic processes, Statistical analysis, Spatial distribution, *Soil water, Hydraulic conductivity.

The spatial variability of certain soil hydraulic properties was examined in the field, and the spatial structures of these properties are presented in terms of the probability density functions, autocorrelation functions, and integral scales. The parameters were: saturated hydraulic conductivity, water entry value, saturated and residual water contents, and a constant which characterizes the pore size distribution of the soil. Each parameter is described at a given depth as a realization of a stationary two-dimensional isotropic and random process. The integral scale value was calculated from the autocorrelation functions for each parameter, and generally decreased with depth. The spatial variabilities of the hydraulic functions are described by the probability density functions and the autocorrelation functions. The results of integral scales and coefficients of variation from this study can be applied to evaluate errors in estimating average values of several hydraulic properties. (Small-FRC)
W82-03315

**ANALYSIS OF LONGITUDINAL DISPERSION IN UNSATURATED FLOW I. THE ANALYTICAL METHOD,**
Massachusetts Inst. of Tech., Cambridge. Dept. of Civil Engineering.
J. L. Wilson.
Water Resources Research, Vol 17, No 1, p 122-130, February, 1981. 10 Fig, 23 Ref.

Descriptors: *Unsaturated flow, *Soil moisture, *Solutes, Dispersion, *Solute transport, Infiltration, Mathematical studies, Mixing.

Analysis of solute displacement in unsaturated soils involves one-, two-, or three-dimensional flow with fixed streamlines. The transport processes are separated into 2 parts: convection with mean flow and dispersive mixing. The convection process is solved exactly, and the dispersive process approximated by singular perturbation techniques. Comparison of theoretical results and field data showed agreement. When the analytical technique is applied to solute transport during steady and transient one-dimensional infiltration, it is observed that nonuniform moisture content in space results in stretching or contracting of a solute pulse as it travels through the soil, whether or not dispersive mixing is present. In addition, for transient infiltration into initially moist unsaturated systems, the rate of solute movement in an unsaturated system is usually smaller than the rate of movement of a moisture change. (Cassar-FRC)
W82-03321

**PONDED INFILTRATION INTO SIMPLE SOIL SYSTEMS: 1. THE SATURATION AND TRANSITION ZONES IN THE MOISTURE CONTENT PROFILES,**
Sydney Univ. (Australia). Dept. of Soil Science.
W. J. Bond, and N. Collis-George.
Soil Science, Vol 131, No 4, p 202-209, April, 1981. 4 Fig, 2 Tab, 27 Ref.

Descriptors: *Moisture content, *Soil water, *Infiltration, Physical properties, Saturation zone, Saturated soils, Transition zone, Free water, Sand, Air entrainment.

Early experimental work involving both moisture content and total potential profiles conducted by Bodman and Colman (1943) resulted in the identification of five features of soil moisture content profiles: saturation zone, transition zone, transmission zone, wetting zone, and wetting front. This study was designed to measure as accurately as possible the basic physical properties of soil during ponded infiltration in simple soil systems and to describe the phenomena occurring during this process. A fine sand from which silt and clay fractions had been removed was used for this study. The experiments demonstrated that saturation and transition zones do exist in the moisture content profiles during ponded infiltration of this simple soil. The saturation zone was not found to be associated with a zone of high total potential gradient. Accepted notions concerning the encapsulation of air when porous materials containing air are wetted and the continual solution of encapsulated air by the infiltration water are used to propose a mechanism for the formation of the saturation and transition zones in simple soil systems. (Carroll-FRC)
W82-03323

**MODELING NITROGEN TRANSPORT AND TRANSFORMATIONS IN SOILS: 1. THEORETICAL CONSIDERATIONS,**
Louisiana State Univ., Baton Rouge. Dept. of Agronomy.
H. M. Selim, and I. K. Iskandar.
Soil Science, Vol 131, No 4, p 233-241, April, 1981. 7 Fig, 24 Ref.

Descriptors: *Nitrogen, *Soil profiles, Mathematical models, Finite difference methods, Nitrification, Denitrification, *Soil water, Ammonium, Flow characteristics, Soil water movement.

Soil water movement directly affects the transport of the water-soluble nitrogen species in the soil, while various organic and inorganic soil nitrogen species influence the chemical and microbiological processes responsible for the various reversible and irreversible nitrogen transformations in the soil.

Mathematical modeling of nitrogen behavior in the soil system has either considered the transport and transformation of nitrogen under steady-state water flow conditions or described the fate of soil nitrogen under nonsteady or transient water flows. The numerical model presented here simulates the transient water flow and nitrogen transport and transformations in multilayered or stratified unsaturated soil profiles. The nitrogen submodel considers nitrification, denitrification, immobilization, mineralization, and ionic exchange of ammonium, as well as uptake of nitrogen by plants. Finite difference approximation of the nitrogen transport and transformation equations is used simultaneously with the water flow equation for transient-unsaturated flow conditions in this model. Model evaluation and sensitivity analyses were conducted for a wide range of values for the rate of nitrification, distribution coefficient for ammonium exchange, and rate of nitrogen uptake. (Carrol-FRC)
W82-03324

**ZINC DEFICIENCY IN WETLAND RICE ALONG A TOPOSEQUENCE OF HYDROMORPHIC SOILS IN THE PHILIPPINES. I. SOIL CONDITIONS AND HYDROLOGY,**
International Rice Research Inst., Los Banos, Laguna (Phillippines).
N. V Van Breemen, D. D. Quijano, and L. N. Sen.
Plant and Soil, Vol 57, No 2/3, p 203-214, 1980. 2 Fig, 5 Tab, 17 Ref.

Descriptors: *Zinc, *Rice, *Philippines, *Drainage, *Soil-water-plant relationships, Hydrology, Bicarbonate, Calcium, Magnesium, Carbon dioxide, Soil gases, Hydrogen ion concentration, Arable land, Artesian wells, Subsurface waters, Percolation.

Zinc deficiency was studied along a 500 meter toposequence in volcanic soil in the Philippines. There were noticeable differences between crops and conditions in the upper and lower fields. In the higher fields (45 meters) above sea level, rice grew well. Zn content of dry soil was 0.15 mg per kg, and percolation was dominant. Dissolved Mg(2+) and bicarbonate in wet soil samples were (given as ionic equivalents in moles per cu meter):19 for 1/2Mg(2+) and 22 for bicarbonate in the highest field. In contrast, the poorly drained fields on the footslope (43 meters above sea level), with Zn levels of 0.10-0.12 mg per kg, grew poor crops. Upwelling of groundwater was present: 1/2Mg(2+) was 26-30, and bicarbonate 29-33. In the toeslope area, only grass and shrubs grew. Here, upwelling artesian well water high in dissolved CO2 (pH 6.5) produced CaCO3 precipitation. A subsequent paper will explain the relationship of these peculiar physical, chemical, and mineralogical characteristics with Zn deficiency. (Cassar-FRC)
W82-03328

**PONDED INFILTRATION INTO SIMPLE SOIL SYSTEMS: 3. THE BEHAVIOR OF INFILTRATION RATE WITH TIME,**
Sydney Univ. (Australia). Dept. of Soil Science.
W. J. Bond, and N. Collis-George.
Soil Science, Vol 131, No 6, p 327-333, June, 1981. 3 Fig, 15 Ref.

Descriptors: *Infiltration rate, *Ponding, *Soils, Mathematical studies, Soil water, Infiltration, Soil absorption capacity.

The behavior of infiltration rate with time during ponded infiltration into simple soil systems is examined using experimental results previously reported by the present authors. Equations defining the infiltration rate for the saturation zone and for the transmission zone are applied to data from infiltration experiments. this analysis indicates that the infiltration rate is proportional to the total potential gradient in the transmission zone throughout infiltration and that steady-state infiltration will be completely achieved only when the total potential gradient has become constant with time in the transmission zone. The apparent linearity of a measured cumulative infiltration-time relationship is shown not to be a reliable indicator of steady state. An equation based on Darcy's law, which relates the infiltration rate to the total potential gradient in the transmission zone, is derived and experimentally tested. This equation is used to demonstrate that it is impossible to achieve steady state infiltration in simple soil systems. The effect of the saturation and transition zones on the infiltration rate, and errors that occur when infiltration models neglect the existence of these zones, are illustrated using this equation. (Carroll-FRC)
W82-03366

## 2H. Lakes

**THE INFLUENCE OF HYDRODYNAMIC TRANSPORT ON PHYTOPLANKTON DYNAMICS IN HOMOGENEOUS LAKES,**
Cornel Univ., Ithaca, NY.
J-T. Kuo.
PhD Thesis, January 1981. 177 p, 55 Fig, 6 Tab, 72 Ref, 3 Append. University Microfilms International, Ann Arbor, MI; Order No GAX81-10910.

Descriptors: *Model studies, *Water quality, *Lakes, *Hydrodynamics, Nutrients, Water currents, Flow characteristics, *Phytoplankton, Hydrodynamic transport, Circulation.

This research explores the influence of hydrodynamic transport on phytoplankton dynamics in lakes through the use of hydrodynamic and phytoplankton modeling. Variable horizontal and vertical dispersion (or exchange) coefficients in a finite-segment water quality model induced by large scale turbulent flow across segment boundaries may be estimated from the outputs of a lake hydrodynamic model. A steady-state lake circulation model has been demonstrated to be able to generate mean circulation patterns in homogeneous lakes. Both direction and magnitude of currents influence the distribution of phytoplankton and nutrient in the 'fine grid' model of lakes or embayment. The effect of Saginaw River inflow is of importance in the constituents distribution in Saginaw Bay, including phytoplankton. The influence of Genessee River discharge is relatively insignificant to the constituents simulation the Rochester embayment. Calculated results using a time-variable transport regime from a series of steady-state calculations with a circulation model show more variation in constituents concentration when compared to those using temporally constant flows in previous modeling analyses. The importance of hydrodynamic transport on the distribution of phytoplankton chlorophyll in lakes is dependent on the space and time scales of interest. This research demonstrates that as the horizontal grid size of a finite-segment or finite-difference large lake model increases to a certain level, the general biochemical kinetics of plankton and nutrients would dominate over the physical transport process in determining the distribution of phytoplankton and nutrients. (Sinha-OEIS)
W82-03023

**LAKE TROPHIC STATE AND ALGAL GROWTH AS INFLUENCED BY CATION CONCENTRATIONS,**
Science and Education Administration, Fort Collins, CO.
For primary bibliographic entry see Field 5C.
W82-03038

**SOME ECOLOGICAL ASPECTS OF LAKE QARUN, FAYOUM, EGYPT, PART II. PRODUCTION OF PLANKTON AND BENTHIC ORGANISMS,**
Institute of Oceanography and Fisheries, Cairo (Egypt). Inland Waters and Fish Culture Div.
S. A. Abdel-Malek, and M. M. Ishak.
Hydrobiologia, Vol 75, No 3, p 201-208, November, 1980. 5 Fig, 7 Tab, 14 Ref.

Descriptors: *Benthos, *Lakes, *Plankton, Eutrophic lakes, Aquatic life, Benthic fauna, Benthic flora, Biomass, *Lake Qarun, *Egypt, Salinity.

Changes were investigated in the species composition, distribution and abundance of phytoplankton, zooplankton, and benthic organisms inhabiting Lake Qarun in relation to variations in the salinity of the water in different parts of the lake during the period from January 1974 to December 1977. Sampling was conducted monthly from 11 stations. The average number of phytoplankton cells was 152,300 cells/L, and its biomass was 0.365 g C/cubic meter. The average number of zooplankton was 31440/cubic meter and its biomass was 194.19 mg/cubic meter. The average number of benthic fauna was 19889/square meter and its biomass was 400.22 g/square meter. Thus Lake Qarun is a highly eutrophic body of water. When the salinity of the lake reached 30-34%, freshwater planktonic species such as Diaptomus salinus that used to inhabit the lake along with the cladoceran Moina salinarum disappeared completely. Some Rotatoria were able to withstand the high salinity. The new composition of the zooplankton community showed that the marine zooplankton species included not only Acartia latisetosa and Cirripedia nauplii, but also other species such as Polychaeta, Obelia medusae, and others. The benthos of Lake Qarun is characterized by an intensive growth of a few species. The majority of bottom fauna in the lake are Mollusca, mainly Cerastoderma glaucum, 69.84% by weight. (Baker-FRC)
W82-03052

**EFFECTS OF DILUTION ON THE BENTHOS OF AN ALKALINE LAKE,**
National Swedish Environment Protection Board, Uppsala (Sweden). Water Quality Lab.
T. Wiederholm.
Hydrobiologia, Vol 68, No 3, p 199-208, February 16, 1980. 3 Fig, 3 Tab, 19 Ref.

Descriptors: *Saline lakes, *Benthic fauna, *Irrigation effects, Lakes, *Lake Lenore, Soap Lake, *Washington, Species diversity, Eutrophic lakes, Freshwater intrusion, Ecological effects, Irrigation water, Leakage.

The salinity of Lake Lenore, in semi-arid central Washington, declined from about 17 g per liter in 1950 to 1.5 g per liter in 1975 because fresh water leaked into the lake from nearby irrigation projects. Dilution of the lake greatly increased species diversity, from a single halobiontic chironomid species in 1950 (inferred from sampling adjacent, undiluted Soap Lake) to 8 taxa in 1957 (salinity 6.7 g per liter), 10 in 1962 (salinity 2.6 g per liter), 26 in 1971 (salinity 1.9 g per liter), and 29 in 1975 (salinity 1.6 g per liter). The lake at present is well mixed, highly productive, and lacking a reproducing fish population. Concurrent increases in abundance and biomass suggest that the carrying capacity of the lake at earlier, higher salinities was not fully used by the benthic fauna. The sodium bicarbonate containing Lake Lenore at $>$ 2-3 g per liter salinity did not support some of the taxa found in Na-Mg sulfate-type lakes at salinities up to 10 g per liter, demonstrating the importance of ion composition. (Cassar-FRC)
W82-03064

**THE STRUCTURE OF FRESHWATER HUMIC SUBSTANCES AS REVEALED BY 13C-NMR SPECTROSCOPY,**
Lincoln Coll. (New Zealand).
M. A. Wilson, P. F. Barron, and A. H. Gillam.
Geochimica et Cosmochimica Acta, Vol 45, No 10, p 1743-1750, October, 1981. 4 Fig, 2 Tab, 44 Ref.

Descriptors: *Humic acids, *Natural waters, *Nuclear magnetic resonance, Spectroscopy, Chemical analysis, Carbon, Sediments, Soils, Fate of pollutants, Metals, Chelation.

The 13C-NMR spectra of freshwater aquatic humic substances were determined so that a comparison of aromaticity could be made between marine, freshwater and terrestrial sources. Because aquatic plants do not normally contain large amounts of lignin the results should shed light on the origin of freshwater aquatic humic substances and indicate why the materials are such excellent complexing agents for metal ions. The humic substances examined were taken from Lake Celyn, Gwynedd, North Wales. Carboxyl, aromatic, o-alkyl and alkyl resonances were recognizable.

Varying pulse delay from 0.43 to 2.5 sec had little effect on the magnitude of the signal ascribed to aromatic carbon, but there was a small nuclear Overhauser effect. The results indicate that 24% of Lake Celyn humic acid carbon was carboxyl and 40% was aromatic. The high proportion of aromatic carbon suggests that the Lake Celyn humic acid is largely formed from terrestrial humic substances from the surrounding peaty watershed. The paper presents evidence which suggests that the relative mobilities of the individual humic substances are also important. (Baker-FRC)
W82-03095

**EUTROPHICATION OF THE LAKE-RESERVOIR SIDI MOHAMED BEN ABDELLAH, RABAT, MOROCCO (L'EUTROPHISATION DU LAC-RESERVOIR SIDI MOHAMED BEN ABDELLAH PRES DE RABAT, MAROCO),**
Service Controle de Qualite des Eaux, Rabat (Morocco).
H. Abouzaid, and L. Iandner.
Aqua, No 6, p 345-347, 1981. 1 Fig, 1 Tab.

Descriptors: *Eutrophication, *Reservoirs, Lakes, Water quality, *Nutrients, Mathematical models, Model studies, *Morocco, Rabat.

The Lake-Reservoir Sidi Mohamed Ben Abdellah was built for the purpose of supplying water for the coastal zone between Kenitra and Casablanca. The reservoir has a volume of 550 million cubic meters with an average depth of 17 meters. The quality of the water in the reservoir has deteriorated due to eutrophication. This is clearly demonstrated by the difficulties being experienced at the water treatment plant. An intensive study has been undertaken by the National Water Office, with the help of the World Health Organization, to determine what factors are responsible for the harmful effects on water quality in the reservoir. Some of the factors studied include liquid and solid inputs, assessment of nutrients, primary production and supply chain. The study has permitted the optimization of the level of raw water intake and the linking of the hydraulic system of the dam to changes in water quality. Currently a mathematical model of the water quality of the reservoir is being developed. The model should enable the feasibility of diferent methods for fighting eutrophication to be studied. The model will also be able to predict water quality in the short and long term. The model will probably be adaptable to other reservoirs in Morocco as well. (Baker-FRC)
W82-03118

**DYNAMICS OF BACTERIAL SULFATE REDUCTION IN A EUTROPHIC LAKE,**
Wisconsin Univ., Madison. Dept. of Bacteriology.
K. Kingvorsen, J. G. Zeikus, and T. D. Brock.
Applied and Environmental Microbiology, Vol 42, No 6, p 1029-1036, December, 1981. 4 Fig, 2 Tab, 36 Ref.

Descriptors: *Sulfates, *Bacteria, *Growth kinetics, Lakes, *Lake Mendota, Wisconsin, Sulfur bacteria, Sediments, Lake sediments, Kinetics, Trophic state, *Sulfate reduction.

Sulfate reduction by bacteria in the surface sediments and water of Lake Mendota, Wisconsin, was studied with S35 labeled sulfate. Sulfate was reduced rapidly at the sediment surface, having a turnover time of 10-24 hours. Daily sulfate reduction rates ranged from 50 to 600 nM sulfate per cu cm. Much less sulfate reduction took place in the water; rates were 1000 times lower than in the surface sediments. Rates of bacterial sulfate reduction in the sediments were not sulfate-limited at sulfate concentrations > 0.1 nM. Optimum temperature for sulfate reduction was 36-37 C. Lake temperatures were 1 to 13 C during the study. Adding electron donors to laboratory cultures gave the following growth stimulation: hydrogen, 73% n-butanol, 59%; n-propanol, 50%; ethanol, 39%; yeast extract, 32%; glucose, 32%; n-butyrate, 32%; n-propionate, 23%; glycerol, 14%; choline chloride, 14%; acetate, zero; and lactate, zero. Bacterial sulfate reduction is very active in this lake even though it is severely temperature limited. Michaelis-Menton kinetics did not apply to the bacterial population in this lake. (Cassar-FRC)
W82-03119

**PHOSPHORUS-LIMITED GROWTH OF A GREEN ALGA AND A BLUE-GREEN ALGA,**
Alaska Univ., Fairbanks. Inst. of Water Resources.
D. S. Lang, and E. J. Brown.
Applied and Environmental Microbiology, Vol 42, No 6, p 1002-1009, December, 1981. 5 Fig, 1 Tab, 44 Ref.

Descriptors: *Phosphorus, *Algae, *Oligotrophic lakes, Lakes, Cyanophyta, Chlorophyta, Nutrients, Phosphates, Kinetics, *Growth kinetics.

A cyanophyte, Synechococcus Nageli, was better suited for growth in phosphorus-limited oligotrophic waters than a chlorophyte, Scenedesmus quadricauda. The growth kinetics were studied in batch and continuous cultures. The cyanophyte had greater steady-state phosphate transport capability and phosphorus storage capability. It also depleted phosphate to much lower levels than S. quadricauda. In a dual species continuous culture under limited phosphorus the cell dry weights for Scenedesmus reached a peak at 5 days and declined to zero by 28 days. Synechococcus cell dry weights increased from nearly zero at 7 days to a peak at 17 days, followed by a slight decline to 25 days and a slight increase to 35 days, the end of the study. (Cassar-FRC)
W82-03120

**OBSERVATION ON THE OCCURRENCE OF MICROBIAL AGENTS WHICH CAUSE LYSIS OF BLUE-GREEN ALGAE IN LAKE KASUMIGAURA,**
Y. Yamamoto.
Japanese Journal of Limnology, Vol 42, No 1, p 20-27, 1981. 7 Fig, 5 Tab, 28 Ref.

Descriptors: *Microbial degradation, *Algal growth, Eutrophication, Lakes, Bacteria, Microorganisms, Toxicity, Seasonal variation, Distribution patterns, Vertical distribution, *Lake Kasumigaura, *Japan.

Attempts were made to determine the seasonal distribution of microbial agents which cause lysis of blue-green algae in Lake Kasumigaura and to ascertain whether these agents have a major role in the decline of algal blooms. The lake is euphotic; Microcystis are the dominant phytoplankton from June to September. The lake is about 168 square km in surface area with a maximum depth of 7.5 meters and average depth of 4 meters. Samples were taken from four sites at monthly intervals from August 1975 through October 1977. Water pH ranged from 6.8 in the winter to 9.6 in summer and fall. Water temperatures showed seasonal variation, with the lowest at 3.8 degrees C in winter and the highest at 29.2 degrees C in summer. The horizontal distribution patterns of plaques showed increases from July to October 1976 and decreased in February 1977, with high concentrations of chlorophyll a generally preceding the peaks of agents and the occurrence of algal-lysis agents being closely correlated with chlorophyll a contents. Many of the plaques were caused by amebas, bacteria and fungi. It was suggested that perhaps amebas are always present in association with some algae which are preferentially ingested, begin to grow rapidly in such an algal bloom as to increase the chance of feeding, attain to maximum population, and subsequently survive, possibly in cyst-like form, under unfavorable conditions. It is not clear from this study whether there is any significant relationship between the amebal population and the occurrence of bacteria or levels of gram-negative bacteria. (Baker-FRC)
W82-03177

**CONTRIBUTION TO THE LIMNOLOGY OF LAKE PAVIN (FRANCE) II. RELATIONSHIPS BETWEEN NONBIOLOGICAL PARAMETERS--PHYTO AND ZOOPLANKTON IN THE 0-20 METER ZONE (CONTRIBUTION A L'ETUDE LIMNOLOGIQUE DU LAC PAVIN (FRANCE). II. RELATIONS ENTRE PARAMETRES ABIOTIQUES-PHYTO ET ZOOPLANCTON DANS LA ZONE 0-20 METRES),**
Biological Station, Besse-en-Chandesse (France).
J. Devaux.
Hydrobiologia, Vol 68, No 1, p 17-34, January, 1980. 10 Fig, 4 Tab, 21 Ref.

Descriptors: *Zooplankton, *Primary productivity, Lakes, Phytoplankton, *Lake Pavin, *France, Copepods, Cladocerans, Daphnia, Ceriodaphnia, Model studies, Productivity, Limnology, Water quality, Nutrients.

Zooplankton were collected bimonthly from May 1973 to April 1974 at six depths from 0 to 20 meters in Lake Pavin, located in the French Massif Central. The volcanic-origin lake is meromictic, 44 hectares in area, and 98 meters deep. The species studied were: Daphnia longispina, Ceriodaphnia quadrangula, Acanthodiaptomus denticornis, and Cyclops abyssorum. Copepods were present all year, with 2 principal reproduction periods, March-April and October-November. Nauplius larvae of A. denticornus died in winter. A mathematical model illustrated the relationships between phytoplankton and zooplankton and the biophysico-chemical parameters of the lake. The highest values of phytoplankton primary production and of the activity coefficient were found when herbivorous zooplankton development was significant and nutrient concentrations were at their minimum. (Cassar-FRC)
W82-03178

**RELATIONSHIP BETWEEN CHLOROPHYLL-A CONCENTRATION AND PHYTOPLANKTON BIOMASS IN SEVERAL RESERVOIRS IN CZECHOSLOVAKIA,**
Ceskoslovenska Akademie Ved, Prague. Hydrobiologicka Lab.
B. Desortova.
Internationale Revue der Gesamten Hydrobiologie, Vol 66, No 2, p 153-169, 1981. 10 Fig, 4 Tab, 30 Ref.

Descriptors: *Reservoirs, *Biomass, *Chlorophyll a, Nutrients, Light intensity, *Phytoplankton, Plankton.

The results of parallel determinations of phytoplankton biomass and chlorophyll concentration, the relations between these two parameters, and the effect of several factors such as species composition, light, and nutrients on the chlorophyll content in algal biomass are reported. The data were obtained during several years at five continuously studied reservoirs: the Slapy, Hubenov, Vrchlice, Klicava and Orlik. The relationship between phytoplankton biomass and chlorophyll concentration determined on the basis of results obtained from several reservoirs was in all cases positive. The statistical significance of the relationship was usually high, even though there was considerable variability within the mentioned relationship. This was mainly due to the fact that the changes in chlorophyll concentration did not always take place in parallel with the changes in total phytoplankton biomass. The chlorophyll content per unit biomass varied by more than two orders in the same locality in the course of the year. A negative relationship was noted between the phytoplankton biomass and the percentage chlorophyll content. Its closeness was affected by the great variations in chlorophyll content per unit biomass during the year. The percentage chlorophyll content in algal biomass was evidently affected by incident light. No significant effects from the species composition of algae or from nutrient concentration on the chlorophyll content per unit phytoplankton biomass have become evident thus far. (Baker-FRC)
W82-03185

**LIMNOLOGICAL STUDIES OF A FRESHWATER FISH POND AT BURDWAN, WEST BENGAL, INDIA,**
ICAR Research Complex, Shillong (India).
B. K. Mandal.
Japanese Journal of Limnology, Vol 41, No 1, p 10-18, January, 1980. 3 Tab, 22 Ref.

Descriptors: *Limnology, *Ponds, *Lakes, Fish, Plankton, Phytoplankton, Zooplankton, Rotifers,

Crustaceans, Biomass, Aquatic life, Population dynamics, Seasonal variation, Algal blooms, *India.

The seasonal variations of the physico-chemical factors and plankton community of a freshwater fish pond were studied at Burdwan, West Bengal, India, during January to December of 1971. The pond is rectangular in shape, with an area of 4.2 ha. Its seasonal average depth varies from 3.5 meters during the rainy season to 2.0 meters during the dry season. Pond water is transparent for most of the year except the winter months, when a dense growth of Eichornia crassipes SOLMS and Potamogeton nodosus appears. The seasonal variation of pH value ranged from 6.5 to 8.3, with the peak in April and the low point in August. Dissolved oxygen varied from 5.5 to 17.5 mg/liter, high in December and low in May. Free carbon dioxide ranged from 1.5 to 12.0 mg/liter. Chloride content ranged from 80.0 to 180.0 mg/liter, peaking in March. Nitrate content ranged from 0.45 to 1.2 mg/l nitrate-nitrogen, peaking in July. Phosphate ranged from 0.25 to 0.95 mg/liter, peaking in July. Total plankton ranged from 8.7 to 14.2 ml, with a bimodal pattern of seasonal change. Peaks were recorded in February and July. Zooplankton occupied 21.8 to 82.6% of the total plankton volume, with rotifers and crustaceans being the dominant forms. The phytoplankton population in the total plankton varied from 17.4 to 78.2% and was composed of Chlorophyceae, Myxophyceae and Bacillariophyceae. Water blooms lasting until autumn were developed after the monsoon months. The components of the bloom were Microcystis and Anacystis in association with Anabaena. Diatoms were represented by 10 species only and were abundant during the monsoon season. Synedra ulna and Melosira granulata constituted the bulk of the diatom population and were present throughout the year. (Baker-FRC)
W82-03186

**EXPLOITING PAPYRUS,**
King's Coll., London (England). Dept. of Plant Sciences.
P. D. Moore.
Nature (London), Vol 284, No 5756, p 510, April 10, 1980.

Descriptors: *Eutrophication, *Aquatic weeds, Swamps, Papyrus, Nutrient removal, Performance evaluation, Nutrients, *Aquatic plants, Weeds, Nitrogen, Magnesium, Potassium, Phosphorus, *Lakes, Tropical lakes.

Papyrus forms floating swamps in the peripheral zones of tropical lakes which may be effective in absorbing nutrients from lakes in danger of eutrophication. The plant, which is robust and productive, absorbs considerable quantities of nutrient ions during swamp growth. Nutrient losses from death, decay, and leaching of older plants are believed to amount to about 65 percent of the material absorbed. The swamp acts as an effective extractor of nutrients, but much of the extracted material is transported as detritus by the flow-through below the mat. Nutrient absorption is also less when water movement is rapid. There is a high degree of nitrogen fixation within the swamp system. Periodic harvesting and removal of the biomass would increase the efficiency of papyrus swamps as nutrient extractors. Since the most rapid accumulation of nutrients occurs in the early growth stages, frequent cropping of the papyrus should result in a maximum nutrient drain on the lake system. In addition, the harvested papyrus can be used as a fuel. It is recommended that tropical swamps be conserved until their usefulness has been assessed and appropriate management regimes developed. (Carroll-FRC)
W82-03202

**EUTROPHICATION OF THE SALT VALLEY RESERVOIRS, 1968-1973. II. CHANGES IN PHYSICAL AND CHEMICAL PARAMETERS OF EUTROPHICATION,**
Nebraska Univ.-Lincoln. School of Life Sciences.
For primary bibliographic entry see Field 5C.
W82-03214

**THE COMPOSITION AND ECOLOGY OF PERIPHYTON COMMUNITIES IN FRESHWATERS. II. INTER-RELATIONSHIPS BETWEEN WATER CHEMISTRY, PHYTOPLANKTON POPULATIONS AND PERIPHYTON POPULATIONS IN A SHALLOW LAKE AND ASSOCIATED EXPERIMENTAL RESERVOIRS ('LUND TUBES'),**
University of East Anglia Univ., Norwich (England). School of Environmental Sciences.
B. Moss.
British Phycological Journal, Vol 16, No 1, p 59-76, March, 1981. 9 Fig, 30 Ref.

Descriptors: *Phytoplankton, *Population dynamics, *Water chemistry, Nitrogen, Aquatic populations, Diatoms, *Lakes, Eutrophic lakes, *Algae, Seasonal variation, Phosphorus, Plankton.

Previous studies of eutrophication have shown that shading by increasing populations of periphyton algae may reduce macrophyte vigor prior to shading by increasing phytoplankton populations, which proliferate later in the process, resulting in the elimination of submerged macrophytes. Seasonal changes in the populations of both periphyton algae and phytoplankton were examined both in two experimental 20 meter diameter 'Lund tubes' placed in the Hickling Broad and in the Broad itself. Agriculture land drainage and roosting gull populations have contributed to the increasing eutrophication of the lake. Gulls perching on the rims of the Lund tubes have caused these reservoirs to experience even greater eutrophication. The water in the tubes experienced persistent domination by colonial blue-green algae, absence of a spring diatom pulse, severe nitrogen limitation, and scanty periphyton on Potamogeton pectinatus. Phytoplankton chlorophyll a levels were lower in the lake than in the tubes, but an alteration of spring diatom annd summer colonial blue-green algae was found in the lake. The lake also showed less severe nitrogen limitation than the tubes, and abundant periphyton crops, especially of diatoms, developed on P. pectinatus and other macrophytes. Periphyton development in the tubes and in the lake was related to nigrogen availability in these phosphorus-enriched waters. The absence of seasonal variations in the phytoplankton population in the tubes was related to the absence of flushing of the water body in the autumn and winter. (Carroll-FRC)
W82-03217

**STUDIES OF THE HYDROBIOLOGY OF A TROPICAL LAKE IN NORTHWESTERN QUEENSLAND. II. SEASONAL CHANGES IN THERMAL AND DISSOLVED OXYGEN CHARACTERISTICS,**
James Cook Univ. of North Queensland, Townsville (Australia). Dept. of Botany.
C. M. Finlayson, T. P. Farrell, and D. J. Griffiths.
Australian Journal of Marine and Freshwater Research, Vol 31, No 5, p 579-569, October, 1980. 5 Fig, 11 Ref.

Descriptors: *Tropical regions, *Lakes, *Australia, New South Wales, Lake Moondarra, Stratification, *Thermal stratification, Seasonal variations, *Dissolved oxygen, Rainstorms, Precipitation, Hydrobiology.

Seasonal changes in vertical distribution of heat and oxygen in lake waters of Lake Moondarra were revealed by a sampling program extending from April 1976 to August 1978. The lake is man-made and located in northwestern Queensland. Evidence suggests that the lake approximates the warm polymictic type in which no persistent thermal stratification ever develops. During the cooler months, thermal stratification breaks down during the night. In the warmer months, the intense rainstorms prevent the establishment of a persistently stratified water column. The shallowness of the lake relative to its surface area and the prevailing environmental conditions ensure that extensive periods of oxygen depletion do not develop in the water column. A strong, prolonged period of thermal stratification would develop, with subsequent serious effects on the availability of dissolved oxygen in the deeper layers, only in the case in which there were no significant rainstorms within a given year's time. The stratification characteristics of Lake Moondarra set it apart from most Australian lakes, which belong to the warm monomictic type, with complete mixing occurring only in winter. The difference can be attributed to those features of the lake and of the local climatic conditions which prevent the establishment of a stable thermal stratification in the summer months. (Baker-FRC)
W82-03218

**LIMNOLOGIC STUDY OF LAKE PAVIN (FRANCE) 1: ABIOTIC FACTORS AND PHYTOPLANKTON (CONTRIBUTION A L'ETUDE LIMNOLOGIQUE DU LAC PAVIN (FRANCE) 1: FACTEURS ABIOTIQUES ET PHYTOPLANCTON),**
Biological Station, Besse-en-Chandesse (France).
J. Deveaux.
Hydrobiologia, Vol 68, No 2, p 167-189, January, 1980. 17 Fig, 5 Tab, 72 Ref.

Descriptors: *Lakes, *Phytoplankton, Temperature effects, Acidity, Mathematical models, Model studies, Carbon, Nitrogen, Oxygen, Physicochemical properties, *Lake Pavin, *France.

A synthetic mathematical model has been devised to summarize the physico-chemical parameters and phytoplankton relationships in Lake Pavin. The Lake itself is located at 1197 meters in the Massif Central Francais. The lake is a dimictic and meromictic lake of 44 ha in area and 92 meters depth. Bimonthly samples were taken at 8 depths ranging from surface to 40 meters. Sampling was performed between May 1973 and April 1974. The following physicochemical parameters were examined: light energy, temperature, pH, conductivity, available oxygen, nitrogen, phosphorus, silica, and carbon. Dynamics of the phytoplankton populations were also considered, such as cell counts, standing crop, primary production, and photosynthetic pigments. Lake waters are clear, with low conductivity and high concentrations of oxygen in the first 40 meters. The means of nitrogen concentration were between 45 and 279 microg/liter and between 0 and 161 microg/liter for phosphorus in a water column ranging from 0 to 40 meters. In winter and spring the phytoplankton are characterized by the development of Diatoms such as Melosira italica subsp. subarctica and Asterionella formosa, as opposed to low standing crops of Chlorophycea such as Coenococcus, Sphaerocystis, and Chlamydomonas which appear in summer. Photosynthetic activity is maximum during winter for diatom populations. (Baker-FRC)
W82-03219

**ANALYTICAL REFERENCE MATERIALS. III. PREPARATION AND HOMOGENEITY TEST OF LARGE QUANTITIES OF WET AND DRY SEDIMENT REFERENCE MATERIALS FOR LONG TERM POLYCHLORINATED BIPHENYL QUALITY CONTROL STUDIES,**
Canada Centre for Inland Water, Burlington (Ontario).
For primary bibliographic entry see Field 5A.
W82-03224

**PHYSICAL VARIABILITY AND PHYTOPLANKTON COMMUNITIES IV. TEMPORAL CHANGES IN THE PHYTOPLANKTON COMMUNITY OF A PHYSICALLY VARIABLE LAKE,**
McMaster Univ., Hamilton (Ontario). Dept. of Biology.
G. P. Harris, and B. B. Piccinin.
Archiv fur Hydrobiologie, Vol 89, No 4, p 447-473, August, 1980. 11 Fig, 1 Tab, 23 Ref.

Descriptors: *Phytoplankton, *Species composition, *Temporal distribution, *Lakes, Seasonal variation, Algae, Diatoms, Chlorophyta, *Hamilton Harbor, *Lake Ontario, Environmental effects, Euphotic zone, Thermocline, Mixing, Lake circulation, Water circulation, Turbulent flow.

Phytoplankton communities were investigated weekly in Hamilton Harbor, Lake Ontario, during the ice free periods of 1975, 1976, and 1977. The

principal component analysis ordination method proved comparable to the non-metric scaling technique for analysis. The phytoplankton species distribution displayed a broad seasonal pattern each year, varying with the seasonal thermocline. Mixing depth and physical environment affected the precise timing of seasonal succession of species. The week by week plot ordinations showing changes in species assemblages over time indicated periods of stability and periods of change. The changes in species composition were not as rapid as environmental changes, showing an averaging effect. However, these changes were a more sensitive indicator of environmental changes than the absence or presence of a species because the reaction to physical perturbations was not complete until 1-4 weeks afterwards. A critical ratio of euphotic zone depth:mixing zone depth of 0.35 was identified. Below this value diatom growth was favored and green algae performance reduced. On the other hand, abundant green algae were associated with ratios of 0.2 to 1.0. A threshold of 8-9 meters mixing depth was noted in many cases. (Cassar-FRC)
W82-03229

**IMPACT OF NUTRIENT ENRICHMENT IN A WATERCHESTNUT ECOSYSTEM AT TAKAHAMA-IRI BAY OF LAKE KASUMIGAURA, JAPAN. V. DYNAMICS OF ORGANIC DEBRIS,**
Meikei High School, Ibaraki (Japan).
H. Nakono, and H. Seki.
Water, Air and Soil Pollution, Vol 15, No 2, p 215-227, 1981. 10 Fig, 1 Tab, 13 Ref.

Descriptors: *Eutrophication, *Lakes, *Bacteria, *Organic matter, Phytoplankton, Nutrients, Cyanophyta, Water pollution effects, *Lake Kasumigaura, *Japan, Detritus, Decomposing organic matter, Nitrogen compounds, Ecosystems.

Organic debris in the hypereutrophied Lake Kasumigaura, Japan, waterchestnut ecosystem showed dynamic fluctuations throughout the year. Profiles of particulate and dissolved organic matter were similar--high concentrations in summer and low in winter. Particulate organic matter, primarily detritus formed from phytoplankton and heterotrophic microorganisms, was present in 2 to 40 times greater concentrations than dissolved organic carbon. Dissolved organic carbon was dependent on excretion of extracellular products by living phytoplankton and by decomposition of phytoplankton. This material was utilized by heterotrophs, such as procaryotic bacteria. Turnover rate of dissolved organic matter, the time required for organic matter to be entirely removed by heterotrophs, was 52 days during blue-green algal bloom in summer, 61 days after the summer bloom in autumn, 101 days during the eucaryotic phytoplankton bloom in spring, and 188 days after the spring bloom in early summer. This is very rapid compared with a few thousand years in the deep oceanic region. Dissolved organic carbon concentration was 100 micrograms per liter at the end of autumn when heterotrophic activity was greatest. In this lake the relative distribution of total organic matter was as follows: during blue-green algal bloom--organic solute 100, detritus particle 200, phytoplankton 2,000, bacteria 40; during non-bloom period--organic solute 100, detritus particle 100, phytoplankton 400, bacteria 60. For comparison, the distribution of oligotrophic ocean water is: organic solute 100, detritus particle 10, phytoplankton 2, and bacteria 0.2 (Cassar-FRC)
W82-03231

**THE PHOSPHORUS CYCLE IN GERMINSTON LAKE. 1. INVESTIGATIONAL OBJECTIVES AND ASPECTS OF THE LIMNOLOGY OF THE LAKE,**
Rand Afrikaans Univ., Johannesburg (South Africa). Research Group for Freshwater Biology.
J. F. Vermaak, J. H. Swanepoel, and H. J. Schoonhee.
Water SA, Vol 7, No 3, p 160-165, July, 1981. 3 Fig, 3 Tab, 29 Ref.

Descriptors: *Phosphorus, *Limnology, *Lake restoration, Mine drainage, Hydrogen ion concentration, Alkalinity, Aquatic plants, Sago pondweeds, Germiston Lake, *South Africa, Cycling nutrients.

The fate of P32 in a freshwater lake, Lake Germinston, invaded by the submerged macrophyte P. pectinatus, was investigated as part of a study on the limnology of the lake and aspects of the history of its recovery from severe mine pollution. The lake has a catchment area of 1174 ha and a maximum water capacity of 2839 x 10 to the 6th power cu m. It is in a highly industrialized area and receives mineralized seepage water from a gold mine. Industrial inputs to the lake were stopped; its water was alkalinized, and the pH buffered. In this study, the water in the lake was analyzed and the biomass of Potamogeton was determined. Excessive growth of water weeds developed during the lake's recovery from pollution. P. pectinatus biomass reached peaks during the summer, autumn, winter, and spring respectively in the order: 1:2:4:8. Phosphorus contents of the plant tissue for the same periods were related as 1:1:2:1.4. P. pectinatus may be playing a controlling role in the lake ecosystem with respect to the phosphorus cycle. (Small-FRC)
W82-03234

**PALAEOECOLOGICAL STUDIES OF LAKES IN THE HIGHLANDS OF PAPUA NEW GUINEA. I. THE CHRONOLOGY OF SEDIMENTATION,**
Liverpool Univ. (England). Dept. of Geography.
For primary bibliographic entry see Field 2J.
W82-03235

**MECHANISMS OF RAPID PHOTOSYNTHETIC ADAPTATION IN NATURAL PHOTOPLANKTON COMMUNITIES. II. CHANGES IN PHOTOCHEMICAL CAPACITY AS MEASURED BY DCMU-INDUCED CHLOROPHYLL FLUORESCENCE,**
Department of Scientific and Industrial Research, Taupo (New Zealand). Freshwater Section.
W. F. Vincent.
Journal of Phycology, Vol 16, No 4, p 568-577, 1980. 10 Fig, 3 Tab, 45 Ref.

Descriptors: *Phytoplankton, *Photosynthesis, *Lake Taupo, *New Zealand, Nutrients, Light intensity, Chlorophyll, Fluorescence, Ecology, Lake District, England, Lake Rotorua.

The study examines the time-response of photosynthetic capacity and fluorescence characteristics of three dissimilar phytoplankton communities exposed to changing light or nutrient levels. Diel variation in photochemical capacity under natural and controlled conditions was measured by DCMU-induced fluorescence in oligotrophic Lake Taupo, New Zealand. The effects of Langmuir circulation on photosynthesis were examined in an oligotrophic water body in the English Lake District. Finally, the extent of photosynthetic and fluorescence response to increased nutrient availability and the probable effect of such photosynthetic regulation for growth were assessed with several bioassays on Lake Rotorua, a eutrophic water body with pronounced nitrogen limitation. The results from the three separate plankton communities demonstrated that photochemical capacity may vary markedly both over the 24 hr cycle and in response to changing light and nutrient conditions. Taupo plankton incubated under a controlled light/dark cycle demonstrated a much greater variation in cellular fluorescence capacity than could be explained by the circadian rhythm detected in low light cells. The pattern and amplitude of circadian rhythms of cellular fluorescence capacity appear to be highly dependent on species composition. These variations may in part reflect rapid tuning of electron transport capacity to changed environmental conditions. (Baker-FRC)
W82-03244

**THE EFFECT OF SUSPENDED MATERIALS ON THE ZOOPLANKTON, I. NATURAL ENVIRONMENTS,**
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
R. Zurek.
Acta Hydrobiologica, Vol 22, No 4, p 449-471, 1980. 2 Tab, 55 Ref.

Descriptors: *Turbidity, *Suspended solids, *Zooplankton, Ponds, Reservoirs, Phytoplankton, Toxicity, Water quality.

The significance of suspension upon zooplankton populations was investigated in a pond and two reservoirs. Water samples were analyzed for heterotrophic bacteria, turbidity, oxygen, chlorophyll alpha, organic matter and mineral composition. The pond contained a great deal of phytoplankton with a maximum turbidity of 1200 mg SiO2/cu dm or 123 mg of mineral fixed residue. The suspension was significantly noxious for Keraratella cochlearis, K. quadrata, Trichocerca cylindrica, Ceriodaphnia pulchella, Daphnia pulex and Chaoborus/crystallinus. Seston from the lowland reservoir had a maximum turbidity of 119.5 mg SiO2/cu dm. It had a significant negative effect on Daphnia cucullata, cladocerans and copepods. However, it stimulated the development of rotifers. The upland reservoir had a turbidity of over 300 mg SiO2/cu dm, and zooplankton was practically absent. There was a negative relationship with turbidity for all species. (Small-FRC)
W82-03313

**CONTRIBUTION TO HIGH ALTITUDE LIMNOLOGY OF THE HIMALAYAN SYSTEM I. LIMNOLOGY AND PRIMARY PRODUCTIVITY OF THE PLANKTON COMMUNITY OF NILNAG LAKE, KASHMIR,**
Kashmir Univ., Srinagar (India). Dept. of Botany.
M. A. Khan, and D. P. Zutshi.
Hydrobiologia, Vol 75, No 2, p 103-112, October, 1980. 7 Fig, 3 Tab, 25 Ref.

Descriptors: *Lake classification, *Water quality, *Mountain lakes, *Nilnag Lake, *Kashmir, India, *Himalaya Mountains, Eutrophication, Nutrients, Phytoplankton, Zooplankton, Aquatic plants, Mesotrophic lakes, Dimictic lakes, Primary productivity, Light penetration, Secchi disks.

Dimictic Nilnag Lake (altitude 2180 meters, area 6.3 ha) in the Kashmir Himalayas at 33 degrees 52 min N and 74 degrees 42 min E was studied during 1974-76. Secchi transparencies ranged from 1 meter in November 1974 to 2.3 meters in April 1976. Vertical extinction coefficients were 0.73-1.7. The pH varied from 7.8 to 8.4, with little difference between surface and bottom waters. Dissolved oxygen levels of surface water varied from 5.1 mg per liter in summer to 10 mg per liter in autumn. Ca(2+) was the dominant cation and bicarbonate, the dominant anion. Specific conductivity ranged between 232 and 370 micro s at 25 C; total alkalinity, 147-220 mg per liter as CaCO3; nitrates, 19.0-30.5 micrograms per liter; and phosphates, 6.0-12.5 micrograms per liter. Annual production of the lake was estimated at 90-100 g carbon per sq meter. Macrophyte life was rich and varied. Most abundant phytoplankton were Cyanophyceae, Chlorophyceae, Bacillariophyceae and Chrysophyceae. Rotifers, cladocerans, and copepods were the most abundant zooplankton. This lake, classified as mesotrophic, shows the effects of human activity in the catchment. (Cassar-FRC)
W82-03314

**IRON-MANGANESE BANDING IN ONEIDA LAKE FERROMANGANESE NODULES,**
South Carolina Univ., Columbia. Dept. of Geology.
W. S. Moore.
Nature (London), Vol 292, No 5820, p 233-235, July 16, 1981. 2 Tab, 10 Ref.

Descriptors: *Lake sediments, *Iron, *Manganese, *Oneida Lake, New York, *Chemical composition, Oxides, Iron compounds, Metals, Ferromanganese nodules, Oxygen depletion.

Ferromanganese nodules in the oceans and in freshwater lakes usually develop layers rich in manganese oxides alternating with layers rich in iron oxides. The process producing this layering pattern is unknown, as is the process producing the nodules. Field studies and laboratory experiments were conducted to investigate these phenomena in Oneida Lake, a freshwater lake near Syracuse, New York. Both freshly precipitated ferromangan-

ese deposits and the surfaces of nodules exposed to the lake water are rich in manganese. Nodules buried in lake sediments have surface layers enriched in iron. Laboratory experiments demonstrated that burying a nodule in lake sediments for several months results in the formation of a skin rich in iron and depleted in manganese. Manganese oxide on the nodule surface appears to accept electrons from carbon oxidation in the sediments, mobilizing manganese ions. This reduction and mobilization of manganese from the nodule surfaces during periods of anoxic sediment cover seems to produce the high iron layers observed in the nodules. (Carroll-FRC)
W82-03342

**ACIDIFICATION IN 50 NORWEGIAN LAKES,**
Oslo Univ. (Norway).
J. Okland.
Nordic Hydrology, Vol 11, No 4, p 25-32, 1980. 5 Fig, 1 Tab, 13 Ref.

Descriptors: *Acid water, *Norway, *Water analysis, *Lakes, Hydrogen ion concentration, Hardness, Acid rain, Air pollution, Fallout.

Since the 1950's significant acidification has taken place in southeastern Norway lakes. There were two observation periods, 1953-57 and 1963-70. For the 50 lakes studied, the average pH dropped from 7.0 to 6.8, a statistically significant change; total hardness showed no significant change. In the low total hardness group (less than or equal to 1 degree dH) average pH changed from 6.6 to 6.3 and average H+ concentration increased by 4.33 times 10 to the minus 7th power mol per liter, equivalent to a 233% change. For the high total hardness lakes (greater than 1 degree dH) there was no statistically significant change in acidity. Lakes with low total hardness appear vulnerable to acidification. Such lakes are located all over Norway and predominate in some areas. (Cassar-FRC)
W82-03344

## 2I. Water In Plants

**WATER USE EFFICIENCY IN DOUGLAS FIR: THE NATURE OF PLANT RESPONSE TO SELECTED ENVIRONMENTAL VARIABLES,**
Washington Univ., Seattle. Dept. of Botany.
F. C. Meinzer.
PhD Dissertation, 1981. 173 p, 27 Fig, 3 TAb, 4 Plates, 113 Ref, 3 Append. University Microfilms International, Ann Arbor, MI; Order No GAX81-13464.

Descriptors: *Water use efficiency, *Irradiation, *Trees, Vapor pressure, Stomatol transpiration, Adaptation, Environment, *Douglas fir, *Pacific Northwest, Stomatal behavior.

Potted, four-year-old, 80 to 100 cm tall Douglas fir plants were used to assess the effects of changes in irradiance and ambient vapor pressure on stomatal behavior and gas exchange. The role of the observed stomatal responses in the regulation of efficiency of water use, and the physiological bases of the responses were examined. Observed plant performance in relation to changing environmental variables was used as an empirical estimate of the relative importance of regulation of water use efficiency as a component of adaptive stomatal behavior for Douglas fir. Stomatal responsiveness of Douglas fir to light and humidity was observed to vary according to the season of the year and degree of maturity of the foliage. The observed patterns of stomatal behavior and gas exchange are discussed in the context of ecologically adaptive behavior under the prevailing climatic regimes west of the Cascade Mountains in the Pacific Northwest. (Sinha-OEIS)
W82-03019

**MODELS OF WATER TRANSPORT IN THE SOIL-PLANT SYSTEM: A REVIEW,**
Auburn Univ., AL. School of Engineering.
F. J. Molz.
Water Resources Research, Vol 17, No 5, p 1245-1260, October, 1981. 11 Fig, 127 Ref.

Descriptors: *Model studies, *Soil-water-plant relationships, Water transport, Plant water potential, Soil moisture, Reviews.

Information is presented on water movement in plant and soil-plant systems. Emphasis is placed on water movement in soil containing roots and on a general approach to water transport in living plant tissue. Detailed quantitative studies of water extraction by plant roots date back to studies by Gardner published in 1960. Many contemporary models have been built around extraction functions in the Darcy-Richards equation. Several such functions are listed, along with their applications, relative advantages, and limitations. In a series of papers appearing in 1958 the first detailed quantitative description of water transport in plant tissue was published. The approach developed then resulted in a diffusion equation, which could be written with water potential as the dependent variable. The derivation assumed that water movement was primarily from vacuole to vacuole. Subsequent workers have refined and extended the development to include water movement in cell walls and plasmodesmata. The development, interpretation, and application of these models over the past decade is presented. It can be stated that contemporary models of water transport in plant tissue are oversimplified. However, they have been subjected to some successful testing and they provide a framework within which to devise experiments. Moreover, the recent development of sophisticated experimental techniques should result in more detailed model testing during the 1980's. (Baker-FRC)
W82-03066

**STRUCTURE AND FUNCTION OF MYCORRHIZAL RHIZOMORPHS WITH SPECIAL REFERENCE TO THEIR ROLE IN WATER TRANSPORT,**
Sheffield Univ. (England). Dept. of Botany.
J. A. Duddridge, A. Malibari, and D. J. Read.
Nature, Vol 287, No 5785, p 834-836, October, 1980. 2 Fig, 1 Tab, 14 Ref.

Descriptors: *Rhizosphere, *Water transport, *Plant physiology, *Soil-water-plant relationships, Absorption, Plant water potential, Soil water, Forests, Root zone, Pine trees, Trees, Arid climates.

The potential of mycorrhizal rhizomorphs to absorb and transport water was examined in laboratory tests. Mycorrhiza cultures were synthesized under aseptic conditions and inoculated with Suillus bovinus fungus. Three seedlings were transferred to peat and exposed to tritiated water supplies. Rhizomorphs emerging from the cup were sliced into sections from top to root. Scintillation counting of each section revealed that the water had moved from both the upper and lower source cups through rhizomorphs to mycorrhizal roots and shoots in just 1 hour. Water movement was dependent on the presence of a rhizomorph connection from source cup to seedling. Ultrastructural analysis showed great differentiation in this type of rhizomorph. Their diameters were between 6 and 20 micrometers and resembled the xylem vessels of higher plants. These rhizomorphs may absorb water and facilitate its transport over ecologically significant distances. Investigations are being conducted to select mycorrhizal associates which are capable of improving the performance of forest crops, especially in semiarid regions. (Geiger-FRC)
W82-03190

**CEREAL YIELDS AND DROUGHT RESISTANCE,**
Agricultural Research Council, Trumpington (England). Plant Breeding Inst.
S. A. Quarrie.
Nature (London), Vol 285, No 5767, p 612-612, June 26, 1980.

Descriptors: *Cereal crops, *Drought resistance, *Crop yield, *Great Britain, Water use efficiency, Plant growth, Plant morphology.

Cereal yields in the United Kingdom have been increasing for the past 30 years and are now 80 percent higher than they were in 1950. Studies of the effectiveness of breeders in improving cereal yields have shown that the best of the new varieties of winter wheat consistently provided yields about 40 percent higher than those of old varieties, dating back to 1908. The new varieties, which are much shorter than the older varieties, have experienced reductions in stem weight which have been exactly balanced by increases in grain weight. However, since there is a limit to how far stem weights can be reduced with matching increases in grain yield, varieties capable of giving a greater biomass yield must be developed if the trend of increasing yields is to be continued. Since an increase in biomass yield would probably require increased water use, emphasis must be placed on more efficient use of available rainfall and stored water. Several studies have suggested strategies for improving the drought resistance of new varieties through breeding. Studies have investigated the effects of stomatal frequency on transpiration in related lines of barley, the genetic variability in the length and number of wheat roots, the biochemistry of water stress, and the effect of the plant hormone abscisic acid on drought resistance. Although many physiological and morphological characters are significant for water use efficiency, the useful variation for a given character within a cereal species may be limited. (Carroll-FRC)
W82-03195

**POSSIBLE ROLE OF ABSCISIC ACID IN REDUCING SEED SET IN WATER-STRESSED WHEAT PLANT,**
New South Wales Dept. of Agriculture, Tamworth. Tamworth Agricultural Research Center.
J. M. Morgan.
Nature (London), Vol 285, No 5767, p 655-657, June 26, 1980. 1 Fig, 2 Tab, 11 Ref.

Descriptors: *Seeds, *Crop yield, *Wheat, Soil-water-plant relationships, Water stress, Plant growth, Plant morphology, Leaves, Water deficit, Turgidity, *Abscisic acid.

A reduction in the number of seeds set per spikelet as a result of an increase in male sterility is one of the major effects of water stress on grain yield in wheat. Little is known about the relationship between the loss of pollen viability and the water relations of the developing spikelets, so the mechanisms of this effect of water deficits are not known. The relationship between leaf turgor and seed set was investigated in wheat plants. These studies indicated that seed set may be reduced by water deficits which cause leaf wilting but have no effect on spikelet turgor or relative water content, suggesting that abscisic acid may be involved in the processes causing floret infertility. Abscisic acid content is known to increase substantially when leaves wilt and to modify developmental processes in plants. Laboratory experiments showed that reductions in the seed set due to water stress were accompanied by increases in endogenous abscisic acid in both leaf and spikelet and that foliar application of synthetic abscisic acid at the stage of meiosis also reduced seed set and caused malformation of pollen grains and anthers. The data did not provide sufficient information to determine the precise stage of microsporogenesis at which the abscisic acid acts. However, the results do inicate that mechanisms which maintain leaf turgor during periods of declining water potential are important in reducing yield losses in crop plants growing in semi-arid areas. (Carroll-FRC)
W82-03197

**RESPONSE OF SORGHUM TO MOISTURE STRESS USING LINE SOURCE SPRINKLER IRRIGATION I. PLANT-WATER RELATIONS,**
International Crops Research Inst. for the Semi-Arid Tropics, Patancheru (India).
M. V. K. Sivakumar, N. Seetharama, K. S. Gill, and R. C. Sachan.
Agricultural Water Management, Vol 3, No 4, p 279-289, 1981. 9 Fig, 1 Tab, 8 Ref.

Descriptors: *Sprinkler irrigation, *Soil-water-plant relationships, *Sorghum, *Moisture stress, Water stress, Irrigation, Soil moisture, Stomatal transpiration, Leaves, Water potentials, Plant water potential, *India, Semiarid lands.

A line source sprinkler irrigation system was useful in determining the response of sorghum (Sorghum bicolor L.) to different levels of moisture stress. Data on water use, stomatal conductance, leaf water potential, and leaf temperature showed that water stress varied as a function of the distance from the line source. Since sorghum, an important post-rainy season crop in India, depends on residual soil moisture, it was desirable to have varying levels of soil moisture for quantitative studies under field conditions. Cumulative water use, which increased throughout the season, was always higher in the first four beds closest to the line source, intermediate in beds 5-8, and lowest in beds 9-12. The maximum difference in water depletion (34 mm) occurred 65 days after planting. Both leaf conductance and mean daily leaf water potential decreased continuously throughout the season in all beds and were always highest in beds 1-4. Mean daily leaf temperature steadily increased until about 70 days after planting, then dropped sharply at 75 days and increased thereafter. (Cassar-FRC)
W82-03265

**WHEAT YIELD ESTIMATION IN NORTH-WEST IRAN,**
International Inst. for Land Reclamation and Improvement, Wageningen (Netherlands).
P. J. Slabbers, and F. X. Dunin.
Agricultural Water Management, Vol 3, No 4, p 291-304, 1981. 5 Fig, 4 Tab, 9 Ref.

Descriptors: *Wheat, *Crop yield, *Soil moisture, Agriculture, Model studies, Simulation analysis, *Iran, Semiarid lands, Fallowing, Soil-water-plant relationships, Water management.

A two-stage model was developed to predict the wheat yield for different forms of crop management in an area near Tabriz, Iran, where subsistence farming is practiced. Simulation covered nine soil moisture regimes and two lvels of management (existing and improved). Model results agreed reasonably with the available information on water balance, streamflow, and wheat production. Predicted soil moisture storage before the November sowing varied between 14 mm for a shallow soil in a dry fallow year to 84 mm in a deep soil following a wet fallow year. Evapotranspiration is reported for the critical six week period starting in mid-May. The proportion of fallow storage used by crops decreases with increasing rainfall in the cropping year and with decreasing soil depth. Simulated wheat yields varied between 290 and 895 kg per ha. Improved management practices will produce the greatest yield increases in deeper soils (750 cm) over a wide range of precipitation conditions, especially when fallow is included in the rotation. This model can be applied to any semiarid region where agriculture is marginal. However, the benefits and negative aspects of long-established practices, in this case, the grazing of animals during the fallow season, must be weighed. Allowing animals to graze provides animal feed and weed control but depletes stored soil moisture. (Cassar-FRC)
W82-03267

**PATTERNS OF WATER POTENTIAL AND PHOTOSYNTHESIS OF DESERT SAND DUNE PLANTS, EUREKA VALLEY, CALIFORNIA,**
California Univ., Davis. Dept. of Botany.
B. M. Pavlik.
Oecologia, Vol 46, No 2, p 147-154, 1980. 8 Fig, 2 Tab, 29 Ref.

Descriptors: *Plant water potential, *Photosynthesis, *Desert plants, Sand, *Deserts, Water use efficiency, Ecology, *California.

Patterns of water status and photosynthetic productivity were examined in dune and non-dune desert habitats. Eureka dunes were chosen as a field site because the presence of two perennial endemics suggested a close relationship between the desert sand dune habitat and its restricted taxa. Plants were investigated for mode of photosynthesis (C3 or C4), daily and seasonal patterns of xylem water potential, seasonal patterns of field photosynthesis, and laboratory gas exchange characteristics. All plants surveyed except Swallenia alexandrae used C3 photosynthesis. Dune plants had significantly lower xylem water potentials, dampened seasonal changes in predawn water potentials, and smaller seasonal amplitudes of water potential than plants of the adjoining flats. Moisture conserving traits were observed in the endemic perennials, such as stomal closure at relatively high water potentials and high water use efficiency. Swallenia minimum water potentials during the summer months were a third of those endured by adjacent non-dune larrea. High photosynthetic productivity, high water use efficiency, and carbon allocation to the longitudinal growth of roots and shoots seemed to be important adaptations for plants in the shifting sand and substrate moisture depletion atmosphere of the dunes. (Small-FRC)
W82-03271

**SEMINAL ROOT MORPHOLOGY AND WATER USE OF WHEAT. I. ENVIRONMENTAL EFFECTS,**
Commonwealth Scientific and Industrial Research Organization, Canberra (Australia). Div. of Plant Industry.
R. A. Richards, and J. B. Passioura.
Crop Science, Vol 21, No 2, p 240-252, April, 1981. 3 Fig, 3 Tab, 7 Ref.

Descriptors: *Crop yield, *Moisture availability, Drought, *Wheat, Soil moisture, Resistance, Farming, Climatology, Water use efficiency, *Soil-water-plant relationship.

Possible influence of environmental conditions on the morphology of the seminal root system is investigated in wheat. When wheat was grown mainly on a limited supply of stored soil water, an increase was noted in the axial resistance to water flow in the roots, which served to conserve some of the water for the critical periods during flowering and grain filling. This increase in axial resistance to water flow is accomplished by either decreasing the diameter of the main xylem vessel in the seminal axes or decreasing the number of seminal axes. The effects of different environments, or seed characters which are influenced by the environment, on both these seminal root characters are reported. Few of the many factors studied exhibited an effect. The most notable were grain size, drought and temperature between germination and emergence, and drought when the seed was being produced. Neither root character showed any genotype/environment interactions when contrasting genotypes were grown in different environments. This gives promise that selection for increased resistance could be done under controlled conditions. (Baker-FRC)
W82-03307

**COMPLETION OF THE LIST OF ANALYTICAL SOLUTIONS FOR NUTRIENT TRANSPORT TO ROOTS 1. EXACT LINEAR MODELS,**
Purdue Univ., Lafayette, IN. Dept. of Agronomy.
For primary bibliographic entry see Field 5E.
W82-03327

**CONSUMPTIVE WATER USE BY OPIUM POPPY,**
Indian Agricultural Research Inst., New Delhi.
B. B. Turkhede, R. De, and R. K. Singh.
Indian Journal of Agricultural Sciences, Vol 51, No 2, p 102-107, February, 1981. 3 Tab, 5 Ref.

Descriptors: *Consumptive use, *Water use efficiency, *Crop yield, Irrigation effects, Water stress, Crop production, Agriculture, *Opium poppy.

An experiment was conducted for two consecutive years to determine the critical stages of water requirement for opium poppy, total consumptive use, water use efficiency, and seed yield and morphine content. Fourteen treatments were evaluated, of which 12 represented irrigation at different phenological stages of crop growth. The maximum opium yield and the lowest morphine content in opium were recorded in plots subjected to no stress at any stage of plant growth and receiving all seven irrigations. Morphine yield per hectare was generally higher when the plants were not subjected to prolonged water stress. Opium yield reduction occurred when irrigation was skipped during the rosette and flowering stages. Stress during the flowering stage seemed to encourage seed yield. The water use efficiency of the seven-irrigation treatment was rather low. Water use efficiency was highest when irrigation occurred at 50% ASM (22.2 g opium/cu m water). (Small-FRC)
W82-03356

**PERFORMANCE OF DIFFERENT CROPS WITH RESIDUAL MOISTURE IN VERTISOLS,**
Andhra Pradesh Agricultural Univ. Hyderahad (India).
T. C. Jain, and G. R. Reddy.
Indian Journal of Agricultural Sciences, Vol 51, No 3, p 181-184, March, 1981. 1 Fig, 3 Tab, 4 Ref.

Descriptors: *Crop production, *Soil water, *Water use efficiency, Moisture stress, Soil types, Crop yield, *India.

The capacity of black soils (vertisols) to store sufficient moisture in southern India to support crop production was evaluated in a field study in which different crops were grown in sequence or in relay. The crops depend upon stored soil moisture and on 27 mm of rainfall received during the experimental period. Twelve crops were grown in relay on September 28 and in sequence on October 12, following the rainy season. Pigeonpea was the most successful crop; studies at the time of harvest indicated that the roots of pigeonpea entered deep (107 cm) and could extract water from the deeper, wet layer of soil. Blackgram, cowpea, and greengram gave successful yields when they were sown in later September and early October. Wheat, chickpea, and coriander were recommended for sowing in late October or November only. In economic terms, pigeonpea gave the higest return, while coriander was second due to its high market price. (Small-FRC)
W82-03357

## 2J. Erosion and Sedimentation

**COPING WITH INCREASED STREAM EROSION IN URBANIZING AREAS,**
Rutgers-The State Univ., New Brunswick, NJ. Water Resources Research Inst.
W. Whipple, Jr., and J. DiLouie.
Water Resources Research, Vol 17, No 5, p 1561-1564, October, 1981. 2 Fig, 2 Tab, 7 Ref.

Descriptors: *Uran areas, *Stream erosion, Erosion, Channel erosion, Channel improvement, Model studies, Bed load, Sediment, Bed-load discharge, *Sediment transport, *Uranization.

The increasing channel degradation being experienced in many urbanizing area streams is discussed. Increased flooding caused by intensive land development is related to stream erosion through bed load transport theory. Analysis of these relationships leads to conclusions as to channel design criteria. Current design criteria for culverts crossing such streams should be modified. The modeling of potential bed load carrying capacity for urbanizing area streams by means of the Schoklitsch bed load formula and a standard runoff model shows results which corresponded to the widely observed stream erosion tendency in urban streams. When the models were applied to a partially developed watershed in Princeton Township, New Jersey, it was noted that the bed load carrying capacity at the peak of a 15 year flood has been greatly increased. It is apparent that the criteria for approving stream encroachments should discourage any action to increase channel velocity in areas where bed load capacity has been increased by processes of urbanization. Results regarding culverts suggest that the detention provided during floods by backwater in streams passing through small culverts has a significant flood retardation effect. The replacement of these culverts with those specified by usual design criteria would more than double the detention capacity needed to com-

pensate for future development in the two cases studied. Each culvert provided a significant reduction in stream velocity during floods and constituted an anchor limiting the progress upstream of channel scour. (Baker-FRC)
W82-03067

**SEDIMENT REGULATION PROBLEMS IN SANMENXIA RESERVOIR,**
Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
L. Yuqian, and Z. Qishun.
Water Supply and Management, Vol 5, No 4/5, p 351-360, 1981. 5 Fig.

Descriptors: *Reservoirs, *Sedimentation, *China, *Yellow River, Rivers, *Sanmenxia Reservoir, Design criteria, Flood control, Runoff, Construction, Storage reservoirs, Multipurpose reservoirs.

The Sanmentia Reservoir is a multipurpose hydroproject mainly used for flood control, controlling a drainage area of 684,000 square kilometers, or 92% of the entire Yellow River Basin in China. Dam construction began in 1957 and the river was closed in November 1958. The concrete gravity dam was completed in September 1960, with a maximum height of 96 meters and a total length of 908 meters. There are 12 deep sluices at the 300 meter elevation and two spillways at 338 meters. After the reservoir began to function as a storage basin, serious defects were noted. Backwater deposits extended upstream with remarkable rapidity, endangering the industrial and agricultural activities in the vicinities of the reservoir, and, with the speedy depletion of the storage capacity of the reservoir, the security of the protection against floods in the Lower Yellow River could no longer be assured. Steps were taken to reconstruct the dam. The key problem of reservoir operation is to prolong the life of the reservoir for a long time so that multipurpose benefits may be developed as much as possible. To retain a usable storage capacity it is necessary that the upstream extension of the backwater deposits be controlled and that the aggradation in the downstream of the Yellow River be minimized. The reservoir must regulate not only the runoff but also the sediment. In the reservoir operation, due consideration must be given to the control of upstream extension of backwater deposits and to avoid the disadvantageous effects on the downstream reach of the Yellow River due to the detention of floods in the reservoir. (Baker-FRC)
W82-03072

**A NEW SEDIMENT TRAP EFFICIENCY CURVE FOR SMALL RESERVOIRS,**
Science and Education Administration, Beltsville, MD.
For primary bibliographic entry see Field 8A.
W82-03086

**MOLECULAR DIFFUSION AND THE SEDIMENTARY ENVIRONMENT: RESULTS FROM THE IN SITU DETERMINATION OF WHOLE SEDIMENT DIFFUSION COEFFICIENTS,**
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
P. E. Kepkay, R. C. Cooke, and A. J. Bowen.
Geochimica et Cosmochimica Acta, Vol 45, No 9, p 1401-1409, September, 1981. 8 Fig, 2 Tab, 16 Ref.

Descriptors: *Diffusion coefficient, *Sediments, Dialysis, *Sulfates, *Carbon dioxide, Microbiological studies, Porosity, Solute transport, Pore water, *Halifax Harbor, *Nova Scotia.

A dialysis technique which includes the effects of microbial action was developed for in situ determination of whole sediment diffusion coefficients. This apparatus was used to measure the diffusion of sulfate and total dissolved carbon dioxide (transported primarily as bicarbonate) in sediments of Halifax Harbor, Nova Scotia. Diffusion was related to the porosity of the sediment. Two zones of sediment porosity and diffusion rates were observed, 0-16 cm, and 60-120 cm. Diffusion of total dissolved CO2 was not affected by microbial activity, but transport of dissolved sulfate was significantly affected by microbial reduction of the sulfate pool available for diffusion. The whole sediment diffusion coefficient for dissolved sulfate at the 60 cm level was 16.6% greater in the sterilized core than in the unsterilized core and the in situ sediment. Sulfate could not be detected below the 60 cm horizon. (Cassar-FRC)
W82-03091

**PROGRAMMING MANUAL FOR MOBED - AN UNSTEADY, NONUNIFORM, MOBILE BOUNDARY FLOW MODEL,**
Canada Center for Inland Waters, Burlington (Ontario).
For primary bibliographic entry see Field 2E.
W82-03109

**PALAEOECOLOGICAL STUDIES OF LAKES IN THE HIGHLANDS OF PAPUA NEW GUINEA. I. THE CHRONOLOGY OF SEDIMENTATION,**
Liverpool Univ. (England). Dept. of Geography.
F. Oldfield, P. G. Appleby, and R. Thompson.
Journal of Ecology, Vol 68, No 2, p 457-477, July, 1980. 12 Fig, 3 Tab, 46 Ref.

Descriptors: *Lakes, *Agriculture, *Erosion, *Sedimentation, Papua New Guinea, Bottom sediments, Human population, Ecology, Environmental effects, Sweet potatoes, Crops.

Sediments from three small lakes in the highlands of Papua New Guinea were studied to determine the effects of man's activities on erosion. The volcanic ash bands common to all three lakes aided dating by various methods: sedimentary trace of geomagnetic secular variation, radiocarbon, Pb210, Cs137, and historical evidence. A chronology of 10,000 years of sedimentation was established. Evidence suggests little or no sedimentation occurred during the periods 10,000 to 5,000 and 4,000 to 1,600 years B.P. At Lake Pipiak, still forested at the time of the study in 1973, little variation in sedimentation has occurred in the distant or recent past. However, at Lakes Egari and Ipea, sites of extensive agriculture, mostly sweet potatoes, sedimentation started to increase 150-300 years ago and has increased more rapidly since 1950, when extensive Western contact began. (Cassar-FRC)
W82-03235

## 2K. Chemical Processes

**PRECIPITATION KINETICS OF CALCIUM CARBONATE AND MAGNESIUM HYDROXIDE IN A SCALING SYSTEM,**
Iowa State Univ., Ames. Engineering Research Inst.
R. W. Peters, L. D. Swinney, and J. D. Stevens,.
AIChE Symposium Series, Vol 77, No 209, p 49-66, 1981. 10 Fig, 12 Tab, 14 Ref.

Descriptors: *Chemical reactions, *Water softening, *Chemistry of precipitation, *Scaling, *Hardness, Chemical properties, Water treatment, Wastewater treatment, Kinetics, Industrial water, Thermodynamics, Mathematical equations, Hydrogen ion concentration, Alkalinity.

Experimental studies are described which were performed to determine the precipitation kinetics of calcium carbonate and of the combined calcium carbonate-magnesium hydroxide system. A brief review of the water chemistry, steady state crystallization theory, and thermodynamic fundamentals involved is presented. The kinetics of calcium carbonate and magnesium hydroxide are a sensitive function of pH. The growth rate, nucleation rate, and kinetic order were measured for various alkalinity distributions caused by the addition of lime as the chemical treating agent. Both systems were scale depositing, usually existing in nonstoichiometric ratios of ions. The phase transformation of calcium carbonate from aragonite to calcite is discussed. The growth rate for the simultaneous precipitations of calcium carbonate and magnesium hydroxide was correlated with the residence time and the respective growth rates of the separate precipitations of calcium carbonate and magnesium hydroxide. (Baker-FRC)
W82-03136

**AN ION-ASSOCIATION MODEL FOR ESTIMATING ACIDITY CONSTANTS (AT 25 C AND 1 ATM PRESSURE) IN ELECTROLYTE MIXTURES RELATED TO SEAWATER (IONIC STRENGTH < 1 MOL/KG H20),**
Marine Biological Association of the United Kingdom, Plymouth (England).
For primary bibliographic entry see Field 1B.
W82-03194

**BIOGEOCHEMICAL CYCLING IN AN ORGANIC-RICH COASTAL MARINE BASIN - I. METHANE SEDIMENT-WATER EXCHANGE PROCESSES,**
North Carolina Univ. at Chapel Hill. Dept. of Geology.
C. S. Martens, and J. Van Klump.
Geochimica et Cosmochimica Acta, Vol 44, No 3, p 471-490, 1980. 12 Fig, 7 Tab, 60 Ref.

Descriptors: *Methane, *Sediment-water interfaces, Interfaces, Hydrocarbons, Sediments, Seawater, Bights, Bays, Sounds, Oxidation, *Organic compounds, Seasonal, *Chemical reactions, Bubbles, Coastal waters, *Cape Lookout Bight, North Carolina.

Samples of anoxic organic-rich sediments of Cape Lookout Bight, North Carolina, were secured by gravity coring. Water samples were also taken to establish depth-concentration profiles for dissolved chemical species at depths of 5, 7, and 8 m using Niskin bottles. Methane produced in the sediments was found to enter the water column in two seasonally dependent manners. During November-May and again between June-October the diffusive transport of methane in situ with benthic chambers averaged 49 and 163 micromol/square meter/hour, respectively. High summer sediment methane production caused saturation concentrations, and this resulted in the formation of bubbles near the sediment-water interface. Low-tide hydrostatic pressure release then triggers bubble ebullition. Bubbling maintains open bubble tubes, which apparently enhance diffusive transport. When tubes are present, apparent sediment diffusivities are 1.2-3.1 fold higher than theoretical molecular values. Dissolution of 15% of the rising bubble flux containing 86% methane supplies 170 micromol/square meter/hour or methane to the bight water column during the summer months. The remainder is lost to the troposphere. During bubbling the bottom water methane concentration increases can be predicted using a 5-15 micrometer stagnant boundary layer dissolution model. Advective transport to surrounding waters is the major dissolved methane sink. Aerobic oxidation and diffusive atmospheric evasion are minor within the bight. (Baker-FRC)
W82-03308

## 2L. Estuaries

**DIEL FLUX OF DISSOLVED CARBOHYDRATE IN A SALT MARSH AND A SIMULATED ESTUARINE ECOSYSTEM,**
Rhode Island Univ., Kingston. Graduate School of Oceanography.
C. M. Burney, K. M. Johnson, and J. M. Sieburth.
Marine Biology (Berlin), Vol 63, No 2, p 175-187, July, 1981. 6 Fig, 5 Tab, 57 Ref.

Descriptors: *Salt marshes, *Carbohydrates, Estuaries, Marshes, Tidal marshes, Saline water, Seawater, Estuarine environment, Coasts, Narragansett Bay, Ecosystems, Model studies, Diel flux.

The purpose of this study was to estimate net dissolved carbohydrates (CHO) release and uptake rates and to look for evidence of biological regulation of the CHO dynamics using measurements made at 2 or 3 hr intervals over diel cycles from a New England salt marsh and a 5 meter deep seawater tank designed to simulate the Narragansett Bay estuary. Results from each of the salt marsh studies showed evidence of highly signifi-

cant total CHO (TCHO) accumulation, primarily due to net polysaccharide (PCHO) release, commencing in the late morning or early afternoon and continuing through at least two sampling periods into the early evening. TCHO and PCHO usually reached their daily maxima at the end of this period. Maximum rates of PCHO accumulation in this time period occurred during or just after the period of masimum net system production indicated by the oxygen, acidity, and total carbon dioxide data. No period of PCHO accumulation was sustained over more than one sampling interval during a cloudy day in August. However, a very pronounced PCHO increase occurred on the following clear day, suggesting an association between the photosynthetic rate and PCHO release. PCHO release on the cloudy day was curtailed due to light limitation of photosynthesis. The mechanism connecting photosynthesis with PCHO release is not known. The monosaccharide cycles in the marsh show much smaller net fluctuations relative to PCHO. In the tank study, large PCHO and TCHO excursions were not shown as in the marsh study. There was also a lack of sustained afternoon PCHO increases which were characteristic of the marsh. The multi-parameter diel sampling of confined water masses can yield useful information on the interaction of ecosystem components as well as on their net rates of change. (Baker-FRC)
W82-03168

**VARIATIONS IN BENTHIC COMMUNITY STRUCTURE IN A SUB-TROPICAL ESTUARY,**
Fisheries Research Station, Aberdeen (Hong Kong).
R. S. S. Wu, and J. Richards.
Marine Biology (Berlin), Vol 64, No 2, p 191-198, September, 1981. 9 Fig, 2 Tab, 37 Ref.

Descriptors: *Benthic environment, *Estuarine environment, Estuaries, Coasts, Benthos, Aquatic life, Growth, Population dynamics, Salinity, Sediments, *Hong Kong estuary.

Results are presented of a one year study on the shallow water, benthic community at three stations along an environmental gradient of changing salinity and sediment silt-clay fraction in the Hong Kong estuary. The aims of the study were to provide further information on sub-tropical soft bottom communities and to examine the spatial and temporal variations in the communities in relation to the prevailing environmental gradient. Three sampling sites were established along the north coast of Lantau Island in depths of less than 10 meters. A clear increase in both the total numbers of animals and their biomass was registered when moving from station 1 to 3. The number of different species was highest in March-April and tended to decline over the summer months until September, with a slight increase in October and November. Murex trapa and Portunus hastatoides were abundant at all three stations throughout the year. Salinity was shown to increase from station 3 to station 1. A large decrease in bottom salinity was noted at all stations in the summer months. The proportion of silt-clay fraction in the sediment increased from station 1 to station 3. No significant difference in the organic content of the sediments was noted between the three stations. It was concluded that the total number of animals, biomass as well as the dominance of Turritella terebra in the community decreased, while species diversity increased along a gradient of increasing salinity and decreasing silt-clay fraction of the sediment. (Baker-FRC)
W82-03169

**THE EFFECT OF TIDAL HEIGHTS ON THE DISTRIBUTION AND ABUNDANCE OF COLIFORM BACTERIA IN THE SEDIMENTS OF TWO SITES IN THE MERSEY ESTUARY,**
Manchester Univ. (England). Dept. of Bacteriology.
J. Karthegisan, and M. P. Thomas.
International Journal of Environmental Studies, Vol 14, No 4, p 299-308, 1980. 6 Fig, 5 Tab, 15 Ref.

Descriptors: *Tidal effects, *Coliforms, *Bacteria, Estuaries, *Mersey estuary, United Kingdom, Fate of pollutants, Sewage bacteria, Intertidal areas, Sediments.

Total coliform counts, E. coli type I counts, and viable counts in estuarine sediments were positively correlated with tidal heights in the River Mersey, United Kingdom, as measured during 1976. Chloride levels in the sediments were also highest during the high tide periods. Low tide counts (per 100 ml) were 170-540 total coliforms, 33-240 fecal coliforms, and 100,000 viable. High tide counts were 540-1600 total coliforms, 140-350 fecal coliforms, and 74,000-110,000 viable. (Cassar-FRC)
W82-03180

**STUDIES ON THE SALINIZATION OF COASTAL GROUND WATER. I. CONFINED GROUND WATER IN THE NAKA RIVER ESTUARY (IN JAPANESE),**
Nara Coll. of Education (Japan). Dept. of Geoscience.
Y. Fukuo, T. Kakinuma, Y. Kishi, and M. Ifuku.
Japanese Journal of Limnology, Vol 41, No 4, p 235-248, 1980. 15 Fig, 14 Ref.

Descriptors: *Saline-freshwater interfaces, *Coastal aquifers, Interfaces, Model studies, Saline water intrusion, Aquifers, Groundwater movement, Coasts, Estuaries, Naka River, *Japan, Pumping, Inflow, Mathematical models.

A model was developed to study the problem of sea water intrusion into coastal aquifers. Spatial distribution of the fresh-salt water interface in the steady state is easily determined in either a confined or an unconfined aquifer with arbitrary plane boundaries. The model is applied to the confined groundwater in the Naka River Estuary, Japan, and the spatial distribution of the fresh-salt water interface investigated for changes in pumping volume or in the inflow rate of groundwater. The calculated contours of chloride ion concentrations were in fairly good agreement with those observed in water from deep test wells. (Cassar-FRC)
W82-03326

**DISTRIBUTION OF ANOPLOSTOMA VIVIPARUM (NEMATODA) IN SOUTHAMPTON WATER SEDIMENTS,**
Southampton Univ. (England). Dept. of Oceanography.
S. C. Surey-Gent.
Marine Biology (Berlin), Vol 62, No 2/3, p 157-160, May, 1981. 5 Fig, 2 Tab, 9 Ref.

Descriptors: *Estuarine environment, *Nematodes, *Estuaries, Coasts, *Sediments, Aquatic animals, Distribution patterns, Southampton Water, England.

In March of 1975, 36 sediment cores were collected from 12 sites in Southampton Water. These sites ranged from 2 meters above mean low water to 9 meters below mean low water. The flocculant layer over each sample was carefully removed, and then the remainder of the sample was sectioned into 0.5 cm segments. The juveniles, non-gravid females, gravid females and males of the free-living marine nematode Anoplostoma viviparum Bastian showed markedly different distributions within layers of mud from these samples. Of the total population, 92% of the gravid females occurred in the anoxic layer, and 73% of the juveniles occurred in the flocculant layer; non-gravid females and males were found in about equal numbers in both the flocculant and oxidized layers, but none were found in the anoxic layer. The tidal flow pattern appears to represent the main influence on the horizontal distribution of A. viviparum. The vertical distribution suggests that the gravid females remain in the anoxic layer while they produce their young. Movement of the flocculant layer serves as the means of distributing the nematode throughout the estuary. (Baker-FRC)
W82-03343

**ALPHA-PARTICLE RADIOACTIVITY OF HOT PARTICLES FROM THE ESK ESTUARY,**
Institute for Marine Environmental Research, Plymouth (England).

For primary bibliographic entry see Field 5A.
W82-03345

**GRAPHS FOR SALINE WEDGES IN ESTUARIES,**
Florida Univ., Gainesville. Dept. of Engineering Sciences.
E. Parthenaides, V. Dermisis, and A. J. Mehta.
Civil Engineering (New York), Vol 50, No 1, p 90-92, January, 1980. 2 Fig, 3 Ref.

Descriptors: *Saline water intrusion, *Channel improvement, *Dredging, Estuaries, Mississippi River, Saline-freshwater interfaces, Case studies, Salinity forecasting, *Graphical analysis.

The shape and longitudinal extent of salt water intrusion in a stratified estuary may be predicted using graphs derived and depicted in this paper. The procedure is illustrated by a case of dredging in the south pass of the Mississippi River. Given values are the freshwater discharge, width, total depth, mean fresh water velocity upstream of the toe of the wedge, fresh water density, and difference between densities of the river and sea water. It was calculated that within the main zone of salinity intrusion for the 45 ft depth, the interface level with respect to the fresh water surface would increase from 1.1 to 3.36 ft for a channel deepening to 50 ft. (Cassar-FRC)
W82-03351

**AVAILABILITY OF DISSOLVED FREE GLUCOSE TO HETEROTROPHIC MICROORGANISMS,**
Kiel Univ., (Germany, F.R.). Inst. fur Meereskunde.
K. Gocke, R. Dawson, and G. Liebezeit.
Marine Biology (Berlin), Vol 62, No 2/3, p 209-216, May, 1981. 2 Fig, 3 Tab, 53 Ref.

Descriptors: *Heterotrophic bacteria, *Chemical analysis, *Estuaries, *Glucose, Bacteria, Microbiological studies, Water analysis, Water analysis, Eutrophication.

The concentration of dissolved free glucose was measured in five aquatic biotopes, differing widely in salinity as well as in degree of eutrophication and pollution. The glucose was measured using ion exchange chromatography of sugar-borate complexes, which disclosed glucose concentrations ranging from 4.99 to 9.63 micrograms carbon/liter. No correlation was noted between the amounts of glucose and the trophic characteristics of the biotope. The sum of the transport 'constant' and the natural concentration of glucose was determined as a parameter, using a microbiological method. Instead of being larger, the parameter values were smaller than the concentrations obtained chemically. The range was between 0.62 and 2.72 micrograms glucose-C/liter. Expressed as percentages, the parameter values were between 6.4 and 30.5% of the concentrations of glucose alone. Two reasons might account for the discrepancy. First, not all of the dissolved free glucose may be available to the heterotrophic microorganisms. Second, during the relatively short duration of the experiments, the added C-14 labeled glucose may not be proportionally distributed between the different fractions of the dissolved free glucose. Instead, the fraction of the truly free glucose might be more highly specifically labelled than the absorbed and complexed ones. This would lead to overrepresentation of the presumably small fraction of the truly free form. It is concluded that using the concentration of the dissolved free substances obtained by chemical analysis to calculate flux might be misleading. (Baker-FRC)
W82-03359

**RADAR MEASUREMENTS OF ESTUARINE CURRENTS AND TIDES,**
Birmingham Univ., (England). Dept. of Electronic and Electrical Engineering.
E. D. R. Shearman.
Nature (London), Vol 286, No 5771, p 333-334, July 24, 1980. 4 Fig, 12 Ref.

Descriptors: *Radar, *Remote sensing, *Estuaries, *Water currents, *Tides, Estuarine environment.

A technique for surface current measurement by high frequency radar in the dekametric band, described by A. S. Frisch and B. L. Weber, has now been used to provide area surveillance data in a form directly comparable with theoretical models. The wavelength spectrum and the directional spectrum of sea waves, both wind-driven and swell, can be measured by using a number of radar frequencies and by directing the radar beam in different directions. The wavelength and the directional spectra of sea waves can be deduced by inversion of the second order features in the radar ECHM spectra from a single patch of ocean at a single radio frequency, promising the capability to characterize sea state over a large area of ocean. The coastal-sited 'ground-wave radar' technique developed by Crombie can give coverage up to about 300 kilometers with suitable power and frequency, while a 'sky-wave radar' using ionospheric reaction covers the area between 1,000 and 3,000 kilometers from the radar. The current measuring technique used by the National Oceanic and Atmospheric Administration uses the Doppler effect to analyze the echoes, sorting returns from each direction by frequency. The direction of arrival is then measured by simple relative phase measurement at separated antennas. Application of this technique to the Cook Inlet in Alaska is discussed. (Carroll-FRC)
W82-03360

**A TWO-DIMENSIONAL NUMERICAL MODEL OF THE VERTICAL CIRCULATION OF TIDES IN THE ST. LAWRENCE ESTUARY,**
Quebec Univ., Rimouski. Dept. of Oceanography.
C. De Borne de Grandpre, M. I. El-Sabh, and J. C. Salomon.
Estuarine, Coastal and Shelf Science, Vol 12, No 4, p 375-387, April, 1981. 10 Fig, 20 Ref.

Descriptors: *Tides, *Water circulation, *Water currents, Model studies, Estuaries, *St. Lawrence estuary, Rivers, Salinity, *Vertical distribution, Salinity.

The vertical circulation of tides in the St. Lawrence estuary was studied with a two-dimensional model with a vertical grid. The equations were solved by a finite difference initial-value method. The data needed were topographical data of the estuary, relevant tidal heights, and salinity levels at the estuary mouth and landward boundaries. The model produced water height, vertical and longitudinal salinity and velocity distributions. The model was tested by varying the friction and turbulence coefficients. Model results agreed well with observed values. Although the model has limitations, it can be considered a step toward the development of a three-dimensional numerical model for this estuary. (Cassar-FRC)
W82-03386

**TRACE METAL SPECIATION IN THE FRESHWATER AND ESTUARINE REGIONS OF THE YARRA RIVER, VICTORIA,**
Caulfield Inst. of Tech. (Australia). Water Studies Center.
For primary bibliographic entry see Field 5B.
W82-03387

**THE MEASUREMENT OF DIFFUSION COEFFICIENTS IN THE CONWY ESTUARY,**
Birmingham Univ. (England). Dept. of Civil Engineering.
J. R. West, and A. P. Cotton.
Estuarine, Coastal and Shelf Science, Vol 12, No 3, p 323-336, March, 1981. 10 Fig, 2 Tab, 14 Ref.

Descriptors: *Estuaries, *Diffusion coefficient, Tidal rivers, Tidal effects, Conwy estuary, *Salinity, Tracers, Dye releases, Flow measurement.

The application of the continuous source dye tracing technique to a tidal flow in a saline selection of the Conwy estuary is examined. Specific objectives were to define the problems of the experimental technique, to estimate the values of the transverse and vertical diffusion coefficients, and to investigate the possibility of defining their functional dependence on hydraulic parameters. The reach of the Conwy estuary was chosen because it was hydraulically relatively simple when compared with most estuarine channels. The reach used for the diffusion experiments was straight and about 500 meters long, 80 meters wide, and 5 meters deep. The salinity was generally between 15 and 30 kg/cubic meter during injection periods. Suspended solids concentrations were usually low, at less than 100 mg/liter. The dye plume was traversed at least three times at each depth, and at depth intervals of 1 meter at each of three sections located at about 120, 240, and 360 meters from the injection point. A total of two flood and seven ebb experimental runs were suitable for analysis. The accuracy of the experiments could be improved by additional hydrodynamic data, shorter fluorometer response time and better fixing. The transverse diffusion coefficient, which includes secondary flow effects, was dependent on flow direction and tidal range for the low river flow conditions at the site being investigated. Transverse diffusion coefficients agree fairly well with other laboratory and field data for open channel flow having a large width to depth ratio. Tentative results for the transverse Lagrangian integral time scale have been obtained. The vertical diffusion coefficient was larger for the flood tides than for the ebb tides. The values were smaller for the homogeneous flow but were compatible with the small vertical salinity gradients. (Baker-FRC)
W82-03388

**NITROGEN AND PHOSPHORUS NUTRITION OF CLADOPHORA IN THE PEEL-HARVEY ESTUARINE SYSTEM, WESTERN AUSTRALIA,**
Western Australia Univ., Nedlands. Dept. of Botany.
P. B. Birch, D. M. Gordon, and A. J. McComb.
Botanica Marina, Vol 24, No 7, p 381-387, July, 1981. 6 Fig, 2 Tab, 13 Ref.

Descriptors: *Algae, *Nutrients, Cladophora, Benthic flora, *Peel-Harvey Estuary, *Australia, *Estuarine environment, Nitrogen, Phosphorus, Seasonal variation, Growth rates, Eutrophication, Estuaries.

Cladophora aff. albida (Huds.) Kutz, a nuisance benthic alga growing in the Peel-Harvey estuary system, Australia, appears to store nutrients during winter and spring, periods of high nutrient input, for use in summer and autumn. Tissue nutrient values were usually above the critical concentrations of 21 mg per g dry weight for nitrogen and always below the critical concentration of 33 mg per g dry weight for phosphorus. Nutrient sources are surface sediments and decomposing Cladophora and phytoplankton. The few weeks of high river flow in winter do not allow the Cladophora to reach full storage potential of nutrients. Phosphorus regulation may be an important factor in control of this alga in the estuary. (Cassar-FRC)
W82-03398

# 3. WATER SUPPLY AUGMENTATION AND CONSERVATION

## 3A. Saline Water Conversion

**HEALTH ASPECTS OF WATER DESALINATION,**
Institute of General and Municipal Hygiene, Moscow (USSR).
G. I. Sidorenki, Y. A. Rachamanin, and E. K. Strijak.
Aqua, No 6, p 339-343, 1981. 4 Ref.

Descriptors: *Desalination, *Public health, *Water quality, Drinking water, *Potable water, Demineralization, Ion exchange, Membrane processes, Reverse osmosis, Electrodialysis, Freezing, Distillation, Water properties, Physical properties.

At present five main methods are used in water desalination programs to provide water for domestic and drinking purposes: distillation, freezing, electrodialysis, reverse osmosis (hyperfiltration) and ion-exchange. Freezing and distillation involve profound structural transformations of the water and changes in its gaseous composition, in the composition of the elements present in it, and in the content of organic matter and microorganisms. The distillate from commercial desalination plants is unsafe and cannot be used in public domestic and drinking water supply systems without further treatment. Water desalinated by distillation is practically lacking in mineral salts. The absence or low content of the salts that make water hard leads to changes in the phosphorus and calcium metabolism, to a reduction in the alkaline phosphatase activity of the blood serum, and to a change in the functional state of the thyroid gland. The biologically important trace element fluorine is almost totally absent from distilled water. The ion-exchange and electrodialysis processes of water desalination have a definite bactericidal and virucidal effect, but a buildup of organic matter on the membranes may be problematic. Water desalinated by electrodialysis must be disinfected. Reverse osmosis methods achieve a higher level of purification. The high alkalinity of water softened by sodium cation exchange is a health drawback, as it leads to shifts in the acid-alkali balance and water-salt metabolism of the organism. A thorough sanitary appraisal must be made of all reagents and structural and process materials, including polymers, used in the various water desalination methods. Recommendations for quality control are offered. (Baker-FRC)
W82-03116

**ARTIFICIAL PARTICULATE FOULING OF HYPERFILTRATION MEMBRANES IV. DYNAMIC PROTECTION FROM FOULING,**
Rensselaer Polytechnic Inst. Dept. of Chemical and Environmental Engineering.
G. Belfort.
Desalination, Vol 34, No 3, p 159-169, September, 1980. 4 Fig, 2 Tab, 6 Ref.

Descriptors: *Membrane filters, *Cellulose acetate membranes, *Fouling, Particulate matter, Colloids, *Desalination, Wastewater treatment, Wastewater renovation.

Previous studies have demonstrated that the use of a fixed membrane protective cover above the desalting membrane and facing the colloid and salt feed solution can significantly improve fluxes and reduce salt rejections. However, the cost of using the microporous Nuclepore or Millipore membranes as protective covers is prohibitive. This study reports experimental results for a new inexpensive method to reduce submicron colloidal fouling for hyperfiltration membranes. An inexpensive dynamic precoat protective cover using diatomaceous earth is placed on the high pressure feed water side of the asymmetric cellulose acetate membrane. Use of this cover resulted in increased flux ratios as high as 2.3 with decreased salt rejection ratios of 0.49 over unprotected membranes. Other significant benefits include reduced flux-decline with the protective cover as compared to without the cover and significantly easier removal of the colloidal cake/protective cover than of the cake itself. This method of protection is most attractive for high-flux and medium salt rejection applications for colloidal containing feed solutions. Such applications include the treatment of municipal, industrial, and agricultural wastewaters for reuse and possibly pretreatment for sea water reverse osmosis desalination. The use of the protective cover method in pilot and large-scale plant operations is being investigated. (Carroll-FRC)
W82-03288

## 3B. Water Yield Improvement

**EVALUATIONS OF ILLINOIS WEATHER MODIFICATION PROJECTS OF 1976-1980: A SUMMARY,**
Illinois State Water Survey Div., Champaign.
S. A. Changnon Jr., and C. F. Hsu.
Circular 148, 1981, 31 p, 8 Fig, 9 Tab, 10 Ref.

Descriptors: *Weather modification, *Rainfall, *Cloud seeding, *Radar, *Weather data collec-

tions, Evaluation, Statistics, Meteorology, Rainfall intensity, Rain gages, Rainfall distribution, *Illinois.

This report summarizes the key results of statistical and meteorological assessments of five summer weather modification projects in Illinois. One of the primary goals of this effort is to determine whether summer cloud seeding, using silver iodide, can produce agriculturally beneficial increases in rainfall under varying summer conditions. The basic approach involved a target vs. control area, plus a seeding period vs. historical period evaluations. Data were collected from non-recording raingages, from radar echoes, and from daily rainfall values provided by the National Weather Service. All of the projects involved seeding cumulus clouds during selected periods from mid-June through early September, and were two months or less in duration. The percentage differences (increases or decreases) between the seeded rain and echo values and control values are not statistically or physically significant. In general, the results are mixed. Two projects (years) indicate increases in the target rainfall and/or echoes, one year shows a decrease, and the remainder show no definitive trend. The results also indicate that for various reasons, such as poor photography, the project radar data are often unusable for a meaningful evaluation of possible seeding effects. In addition, all of the projects were of too short a duration to draw significant conclusions. (Atkins-Omniplan)
W82-03006

**APPLICATION OF A SINGLE RESERVOIR OPERATION POLICY TO A RAIN WATER CISTERN SYSTEM,**
Hawaii Univ., Honolulu. Dept. of Agronomy and Soil Science.
A. Lo, and Y. S. Fok.
Water Resources Bulletin, Vol 17, No 5, p 868-873, October, 1981. 7 Fig, 1 Tab, 3 Ref.

Descriptors: *Reservoir operation, *Cisterns, *Water storage, Water consumption, Water harvesting, Rainfall, Tantalus, *Hawaii, Storage capacity, Rain water, Capacity, Feasibility studies, Risks, Water supply.

Rain water cisterns, used in some regions of Hawaii as a primary or supplementary water supply, are economically feasible with proper maintenance and use of a single reservoir operation policy. Dynamic programming analysis was used to study the effects of probable weekly rainfall at Tantalus, Hawaii, and the storage capacity of the cistern on the water consumption policy. A cistern with maximum volume of 37.85 cu m and catchment area of 148.64 sq m receives 4 cu m (1000 gal) for each inch of rainfall. A table summarizes the best combinations of catchment area, storage capacity, optimal draft target, and percent risk for residents of the Tantalus area. A catchment area of 1200 sq ft with 8000 gal cistern has an optimal draft of 2200 gal per week at a 3.5% risk. At the other extreme of the table, a catchment area of 1600 sq ft with 16,000 gal cistern, has an optimal draft of 3000 gal per week at 1.5% risk. The water consumption rate should be lowered if the storage level is low or if the rainfall is low. (Cassar-FRC)
W82-03088

**REANALYSIS OF 'GENERALIZED CRITERIA FOR SEEDING WINTER OROGRAPHIC CLOUDS',**
Water and Power Resources Service, Denver, CO.
D. Rottner, L. Vardiman, and J. A. Moore.
Journal of Applied Meteorology, Vol 19, No 5, p 622-626, May, 1980. 8 Tab, 1 Ref.

Descriptors: *Cloud seeding, *Statistical analysis, Mathematical studies, Weather modification, Clouds, Orographic precipitation.

Vardiman and Moore (1978) presented the results of a study designed to develop generalized criteria for the seeding of winter orographic clouds. That paper discussed various physical stratifications which indicated the bounds of those meteorological and topographical conditions which were likely to produce positive and negative seeding results (seeding windows). However, continuing investigations of seeding windows using these data revealed a serious systematic bias of the original data set. This bias occurred because the Climax I and Climax II data sets included a large number of no-seed cases which were not within the original strict randomization. When this systematic bias was removed, significant changes were found in both the overall and the stratified results. Use of the corrected data set led to mostly non-significant results. The only window that remained significant was one indicating a decrease when unstable clouds with a blow-over trajectory, low moisture, and cloud-top temperatures less than -30C were seeded. (Carroll-FRC)
W82-03173

## 3C. Use Of Water Of Impaired Quality

**DEMONSTRATION OF ANAEROBIC BIOGAS DIGESTERS IN DEVELOPING COUNTRIES. PART III: THE PHILIPPINES,**
Philippines Univ., Manila. Inst. of Public Health.
For primary bibliographic entry see Field 5D.
W82-03226

**OSMOTIC POTENTIALS OF ROOTS OF ONIONS AND THEIR RHIZOSPHERIC SOIL SOLUTIONS WHEN IRRIGATED WITH SALINE DRAINAGE WATERS,**
Technische Univ., Brunswick (Germany, F.R.). Liechtweiss Inst. for Water Research.
U. Schleiff.
Agricultural Water Management, Vol 3, No 4, p 317-323, 1981. 2 Fig, 2 Tab, 13 Ref.

Descriptors: *Irrigation water, *Root zone, *Water reuse, Onions, Saline water, Drainage water, Salts, Agriculture, Osmotic pressure, Impaired water use, *Saudi Arabia.

The reuse of saline drainage water for irrigation of onions in Saudi Arabia was tested by determining the chloride concentration in rhizospheric soil (the layer immediately surrounding the roots, less than 1 mm thick) directly after watering and after 4 days of water depletion. Electrical conductivities of irrigation waters used were 2.4, 4.0, 6.0, and 8.0 mS per cm, obtained by mixing fresh (2.4 mS per cm) with more saline drainage water. Four hours after irrigation, rhizospheric soil contained 3-4.5 meq chloride per 100 g, 3-5 times greater than nonrhizospheric soil; after 4 days, 9-11 meq per 100 g. Nonrhizospheric soil remained at 0.6-1.5 meq chloride per 100 g during the experiment. The osmotic potentials of the rhizospheric soil were -0.5 MPa to -0.9 MPa upon irrigation and -2.0 to 3.0 MPa after 4 days. The concentration of chloride in rhizospheric soil did not reflect the different chloride concentrations of the irrigation waters. When the chloride level of added water increased 300%, the increase of chloride concentration in rhizospheric soil was 150% initially, 50% after 4 hours, and 20% after 4 days. These results contrast with previous findings that salt concentration of rhizospheric soil increased with salt concentration of applied water. Probably, salt concentration reached a critical maximum which was not exceeded. At this point roots may have stopped absorbing soil water, and translocation of salts from the nonrhizospheric soil ceased. (Cassar-FRC)
W82-03263

**ON THE DEPENDENCE OF SALT TOLERANCE OF BEANS (PHASEOLUS VULGARIS L.) ON SOIL WATER MATRIC POTENTIALS,**
Escuela Tecnia Superior de Ingenieros Agronomis, Madrid (Spain). Catedra de Edafologia.
M. A. Parra, and G. C. Romero.
Plant and Soil, Vol 56, No 1, p 3-16, 1980. 10 Fig, 17 Ref.

Descriptors: *Irrigation effects, *Salt tolerance, *Conductivity, Saline water, Irrigation, Crop yield, Water quality, Beans, *Impaired water use.

The salt tolerance of green beans was evaluated in a pot experiment using two irrigation regimes. Saline irrigation waters were prepared by adding increasing amounts of NaCl and CaCl2 to tap water to obtain waters with an electrical conductivity of 0.3, 0.5, and 0.7 mmol/liter and sodium adsorption ratio of 4 mmol/liter. Soil salinization was begun on the 20th day and completed on the 30th day by applying 500 and 1000 ml of saline water per pot at intervals. Thereafter, in the wet treatment, plants were irrigated when the water matric potential ranged from -20 to -30 kPa, and in the dry treatment, plants were irrigated when the water matric potential ranged from -40 to -60 kPa. When soil salinity increased and soil moisture decreased, transpiration rates and leaf extension rates decreased. Leaf extension rates were affected more by decreases in soil moisture. Under wet treatment, crop yields were as much as one and one half times larger than dry treatment yields. The common practice of evaluating the salt tolerance of crops by electrical conductivity alone is not as useful as when irrigation regimes are also considered. (Small-FRC)
W82-03273

**WATER COST ENCOURAGES REUSE AND CONSERVATION,**
Pirnie (Malcolm) Inc., White Plains, NY.
For primary bibliographic entry see Field 5D.
W82-03295

## 3D. Conservation In Domestic and Municipal Use

**AN ECONOMIC ANALYSIS OF WATER CONSERVATION POLICY,**
Rutgers - The State Univ., New Brunswick, NJ.
For primary bibliographic entry see Field 6B.
W82-03090

**REPORT OF COMMITTEE ON CONSERVATION, DEVELOPMENT AND UTILIZATION OF WATER RESOURCES.**
Journal of the New England Water Works Association, Vol 95, No 1, p 66-71, March, 1981.

Descriptors: *Water conservation, *Water policy, *Regional planning, *New England, Federal jurisdiction, Planning, Water resources development, Water use efficiency.

A synopsis was prepared on water conservation activities at the federal, interstate and state levels as of September 1980, and the relationships of the New England Waterworks Association to these activities was discussed. Activities in water conservation on the federal, interstate, state, and local levels point to increased emphasis on evaluation and use of water saving measures wherever practicable. A study report published on water conservation program development and implementation at the state level is intended to provide guidance in this development, but also contains information on responses of specific states to the need to conserve water. Two studies on evaluation and implementation of water conservation measures in New England have been undertaken by the New England River Basins Ccommission, an interstate/federal planning agency, Massachusetts has taken the lead among the New England states in promoting broad application of conservation principles and technology. The New England Water Works Association may involve itself directly in deliberations on water conservation measures. (Cassar-FRC)
W82-03374

## 3E. Conservation In Industry

**TEXTILE WARP SIZE RECLAMATION USING THERMAL PRECIPITATION,**
Auburn Univ., AL.
For primary bibliographic entry see Field 5D.
W82-03034

**WATER POLICY AT INCO METALS COMPANY, ONTARIO DIVISION MILLS,**
Water and Pollution Control, Vol 118, No 5, p 20, May, 1980.

Descriptors: *Water policy, *Water reuse, *Industrial wastewater, Ontario, Canada, Wastewater renovation, Mine wastes, Effluents, Water quality control.

This column presents excerpts from a paper by H. R. Butler, Supervisor, Environmental Control, Ontario Division, Inco Metals Company, presented at a conference of the Canadian Mineral Processors. Inco Metals Company operates 10 mines, three mills, two refineries, a smelter, and an iron ore recovery plant within a 50-kilometer radius of Sudbury, Ontario, and a mine-mill complex on the shore of Lake Shebandowan. The use rate of recycled water in the company's milling operations is more than 95 percent at each mill, both reducing the need for fresh water at the mills and improving the pollutant level of downstream aquatic environments. Effluents from the several facilities are collected in a common receptor, permitting treatment of excess and runoff waters and provision of a process water having a consistent quality. This system also minimizes operating expenses. The mill-mine complex at Lake Shebandowan uses about 330 cubic meters of fresh water per day, with an overall water recycle of 550 cubic meters per day. Mine water is used as flusing water for backfill operations or discharged to the tailings area. The combined tailing supernatant and mine water is used as process water in the mill. (Carroll-FRC)
W82-03251

## 3F. Conservation In Agriculture

**ESTIMATING DISTRIBUTION UNIFORMITY IN LEVEL BASINS,**
Science and Education Administration, Phoenix, AZ. Water Conservation Lab.
A. J. Clemmens, and A. R. Dedrick.
Transactions of the ASAE, Vol 24, No 5, p 1177-1180, 1187, September-October, 1981. 7 Fig, 7 Ref.

Descriptors: *Distribution patterns, *Basins, *Irrigation practices, Mathematical studies, Model studies, Streamflow, Irrigation design, Soil properties, Infiltration rate, Infiltration coefficient, Infiltration.

Factors that control the distribution uniformity of irrigation water applied to level basins were sought, and procedures for estimating the distribution uniformity were presented. Depending on the soil infiltration properties, two types of infiltration functions were studied: a power function for soils that do not reach a constant infiltration rate during an irrigation, and a branch infiltration function for soils that do reach a constant infiltration rate. Of the two methods presented for analyzing the distribution uniformity, the one utilizing a branch infiltration with a constant final infiltration rate is by far the easiest and most straightforward to use. However, the infiltration properties of the soil determine which of the methods is appropriate. For the branch infiltration function, the distribution uniformity is calculated directly. For the power infiltration function, the distribution uniformity has been displayed graphically, since it cannot be computed directly. Both methods for computing distribution uniformity require values for the advance exponent and the advance time. The power function method requires values for the recession time and the infiltration exponent. The branch function method requires values for the final infiltration rate and the average depth of water infiltrated. (Baker-FRC)
W82-03058

**DESIGN PROCEDURE OF SPRINKLING LATERALS: THE MATHEMATICAL BACKGROUND OF A COMPUTERIZED AID,**
Technion - Israel Inst. of Tech., Haifa. Dept. of Agricultural Engineering.
S. Pleban, and I. Amir.
Agricultural Water Management, Vol 3, No 4, p 269-278, 1981. 2 Fig, 6 Ref.

Descriptors: *Sprinkler irrigation, *Irrigation design, *Conveyance structures, Computer programs, Design criteria, Mathematical studies.

This paper presents the mathematical background of an interactive computer program to aid in designing sprinkling irrigation laterals. Several computer programs are used to solve four cases: (1) discharge and pressure distribution along the lateral, (2) pressure at inflow node + Case 1, (3) lateral diameter + Case 2, and (4) maximum permissible number of sprinklers on the lateral + Case 2. Also introduced as needed are: topography, lateral type and diameter, type of sprinklers and riser, spray between sprinklers, number of sprinklers, pressure at inflow node and maximum discharge differences between extreme sprinklers. The conversational mode and rapid response of the programs allows even unskilled users to run the programs correctly. Computational limits permit a 30-sprinkler maximum. (Cassar-FRC)
W82-03174

**EVALUATION OF INFILTRATION MEASUREMENTS FOR BORDER IRRIGATION,**
Science and Education Administration, Phoenix, AZ. Conservation Lab.
For primary bibliographic entry see Field 7B.
W82-03264

**WATER USE AND WATER-USE EFFICIENCY OF WHEAT AND BARLEY IN RELATION TO SEEDING DATES, LEVELS OF IRRIGATION AND NITROGEN FERTILIZATION,**
Haryana Agricultural Univ., Hissar (India). Dept. of Agronomy.
K. P. Singh, and V. Kumar.
Agricultural Water Management, Vol 3, No 4, p 305-316, 1981. 4 Fig, 4 Tab, 16 Ref.

Descriptors: *Water use efficiency, *Irrigation efficiency, *Grain crops, Wheat, Barley, Fertilizers, Water use, Consumptive use, Evapotranspiration, Agriculture, *India.

Under water stress, barley was more productive than wheat, especially under late seeding conditions. Wheat (Triticum aestivum L.) and barley (Hordeum vulgare L.) were studied in India under timely (mid-November) and late (mid-December) seeding conditions, three irrigation levels (I, one irrigation at crown rooting in wheat and at active tillering in barley; II, as in I plus one irrigation at flowering in wheat and flag-leaf in barley; and III, at 25% available soil water in the active root zone), and four rates of nitrogen application (0, 30, 60, and 90 kg per ha N as calcium ammonium nitrate, divided into two applications). All crops were irrigated to field capacity prior to seeding. Under identical soil water stress barley showed a more favorable leaf water potential and more rapid recovery than wheat. Wheat had a higher transpiration rate than did barley. In irrigation regimes I and II barley used 9 and 21 mm less water, respectively, and outyielded wheat by 27% and 9%, respectively. A 100 mm savings for barley was realized with irrigation regimes I and II as compared with III. In general, water use efficiency decreased with increase in irrigation frequency and delay in seeding. Fertilization increased water consumption by wheat and barley 9% and 8%, respectively, and yield 90% and 100%, respectively, thus increasing water use efficiency. (Cassar-FRC)
W82-03266

**MULTIMILLION-ACRE TEA BAG,**
Svenson and Associates, Watsonville, CA.
G. Svenson.
Civil Engineering (New York), Vol 50, No 2, p 47-50, February, 1980.

Descriptors: *Irrigation efficiency, *Salts, *Irrigation-return flow, Irrigation practices, Irrigation, Agriculture, Water quality, Water conservation, Crop yield.

On-farm irrigation techniques that reduce return flow and thus reduce the salt concentrates deposited by return-flow water are discussed. Improved irrigation efficiency can reduce salt in the water supply, alleviate shortages of water used for other purposes, and prevent over-irrigation, which is detrimental to crops. One development to aid farmers is the lightweight neutron probe, which can measure soil moisture levels accurately in the field. It can be used to read up to 100 sites per day. A method has been developed for applying the data produced by the probe to the various needs of each field and crop under different weather conditions. A scheduling technique is used which identifies the refill point at which irrigation should occur. This simple method was evaluated on a sprinkler-irrigated 1500 acre potato and grain farm, and yield increases well above the 20-year record were experienced. It is difficult to get farmers to cooperate with the new program, however, because there are no incentives in the water allotment system for conserving water. (Small-FRC)
W82-03352

# 4. WATER QUANTITY MANAGEMENT AND CONTROL

## 4A. Control Of Water On The Surface

**1980 PROGRESS REPORT ON BASELINE AQUATIC VEGETATION STUDIES TO DETERMINE THE EFFICACY OF HYBRID CARP (GRASS CARP FEMALE X BIGHEAD CARP MALE) IN TWO CALIFORNIA IRRIGATION CANALS,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
F. L. Nibling, Jr., and J. S. Thullen.
Bureau of Reclamation Report GR-81-11, May 1981. 84 p, 32 Fig, 11 Tab, 10 Ref, 1 Append.

Descriptors: *Aquatic weeds, *Irrigation canals, *Hydrophytes, *Aquatic weed control, Biomass, Myriophyllum, Seasonal distribution, Sago pondweed, Fish, Carp, Hybrid carp, Imperial Irrigation District, California, Baseline studies, Vegetation.

During the 1980 growing season, six field trips were made to develop field techniques and gather information that will eventually be used to document the efficacy of this hybrid carp for controlling aquatic plants (hydrophytes) in irrigation canals. These studies were conducted in the Coachella Valley Water District and the Imperial Irrigation District in southern California. Baseline data were collected on hydrophyte distribution, biomass, and density; root and rhizome biomass; tuber density; and soil composition. In the Coachella Canal, the dominant hydrophyte, Myriophyllum spicatum, was sparse in April, but increased in biomass in each test section throughout the growing season. The hydrophytes in the Wormwood Lateral 3 varied considerably between the test sections. In April, the dominant hydrophyte, Hydrilla verticillata, was sparse throughout the lateral, but by July it had reduced the water-carrying capacity in one section by 50%. Other sections in Wormwood Lateral 3 remained low in biomass throughout the season, with the exception of one section which was dominated by Potamogeton pectinatus and Najas guadalupensis from October through November. The most promising parameters for evaluating the sterile hybrid carp efficacy will likely be hydrophyte biomass, areal coverage, and estimates of relative abundance. (Moore-SRC)
W82-03024

**SEDIMENT REGULATION PROBLEMS IN SANMENXIA RESERVOIR,**
Institute of Water Conservancy and Hydroelectric Power Research, Beijing (China).
For primary bibliographic entry see Field 2J.
W82-03072

**A PLANNING METHOD FOR EVALUATING DOWNSTREAM EFFECTS OF DETENTION BASINS,**
Maryland Univ., College Park. Dept. of Civil Engineering.
M. E. Hawley, T. R. Bondelid, and R. H. McCuen.
Water Resources Bulletin, Vol 17, No 5, p 806-813, October, 1981. 2 Fig, 4 Tab, 4 Ref.

Descriptors: *Detention reservoirs, *Flood control, *Storm runoff, Runoff, *Model studies, Planning, Storm water, Hydrologic models, Reservoirs, Flood peak, Urban hydrology.

A simple, reasonably accurate method for evaluating the potential for adverse downstream effects of storm water detention basins is presented. It does not require a computer or a large data base. The time coordinates of runoff hydrographs are estimated using the time-of-concentration and the Soil Conservation Service runoff curve number. The discharge coordinates are obtained from a simple peak discharge equation. When results of this analysis show that downstream flooding would not be increased by the detention basins, further costly hydrologic analyses may be avoided. This method was applied to the Crabbs Branch watershed, Maryland. Results indicated a 15% increase in peak discharge rate, in good agreement with results from a more detailed modeling method. (Cassar-FRC)
W82-03089

**RELIABILITY PROGRAMING IN RESERVOIR MANAGEMENT 1. SINGLE MULTIPURPOSE RESERVOIR,**
California Univ., Davis. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6A.
W82-03148

**SALINITY AND BIOGENIC MATERIAL IN THE NORTH CASPIAN,**
Kaspiiskii Nauchno-Issledovatelskii Inst. Rybnogo Khozyaistva, Astrakhan (USSR).
D. N. Kutunin, and A. N. Kosarev.
Water Resources, Vol 8, No 1, p 19-28, January/February, 1981. 5 Fig, 7 Tab, 12 Ref. Translated from Vodnye Resursy, No 1, p 77-88, January/February, 1981.

Descriptors: *Salinity, *Nutrients, *Environmental effects, Flow regulation, Reservoir releases, *Caspian Sea, *Volga River, USSR, Rivers, Runoff, Phosphorus, Nitrogen, Silica.

Regulation of Volga River runoff has changed the salinity and nutrient distributions in the North Caspian Sea. The spring flood volume decreased by 11% and the fall-winter discharge increased, causing salinity increases up to 1.6 parts per thousand in summer. Maximum freshening has been shifted from July to June, and the area of freshened waters reduced. Vertical salinity gradients decreased in July-August, improving oxygen saturation, and increased in winter. Relative stability in salinity was observed in 1970-75. Marked salinization, up to 11.5 parts per thousand, occurred in the very dry period of 1975-77. Inorganic P decreased by 20% by 1977. Organic P has varied noticeably but is presently at its 1954-59 level. Silicon has also fluctuated widely. Total nitrogen inflow has increased by 180% in 1971-76 as compared with pre-regulation years. The proportion of inorganic to organic N has decreased. Ammonium N levels have decreased in the sea as a whole but increased in some shallow areas. Organic N levels have decreased slightly since regulation. (Cassar-FRC)
W82-03155

**AQUATIC WEED RESEARCH IN BRITAIN,**
Agricultural Research Council, Oxford (England). Weed Research Organization.
T. O. Robson.
Journal of Aquatic Plant Management, Vol 19, p 47-48, July, 1980. 3 Ref.

Descriptors: *Aquatic weed control, *Weed control, *Drainage systems, Herbicides, Aquatic plants, Water quality control, *England, Fish habitats.

Aquatic weed control in British ditches and rivers is essential to properly drain 3 million acres of valuable agricultural land. Methods of weed control must consider the stringent effluent standards in force and the desirability of maintaining enough aquatic vegetation to support recreational fish habitats. The major problems are not with exotic plants, but with indigenous ones. Mechanical control by cutting is labor intensive, but it does not add chemicals to the environment. Use of newly developed weed cutting machinery is limited because of high costs and difficulties of access on farmed land. Biological control may be possible with the herbivorous grass carp, plant competition, and shade trees on the bank. Herbicides are valuable when total eradication is desired. Newer application methods allow treatments to be selective for a target species and reduce the amount of chemical introduced. (Cassar-FRC)
W82-03187

**TRANSLATORY CHARACTERISTICS OF THE MUSKINGUM METHOD OF FLOOD ROUTING--REPLY,**
Ahmadu Bello Univ., Zaria (Nigeria). Dept. of Civil Engineering.
M. A. Gill.
Journal of Hydrology, Vol 48, No 3/4, p 369-372, November, 1980. 1 Fig, 4 Ref.

Descriptors: *Mathematical studies, *Hydrodynamics, *Flood routing, Flow characteristics, Mathematical equations, Mathematical models.

This response by the author of the article Translatory Characteristics of the Muskingum Method of Flood Routing to comments by Strupczewski and Kundzewicz argues that the conclusions made by the commentors are not relevant to the substance of the original paper. Gill argues that the conclusions and arguments reached by the commentors were based on results obtained by using the Laplace operator, which is applicable in cases in which the lower limit of the integral is zero. However, the lower limit is not zero in the case of the Muskingum equation, so use of the Laplace operator is not appropriate. Gill argues that if the equation he used to define the initial condition is accepted, the arguments put forth by the commentors have no basis. The physical meaning of the time lag and the initial condition are clarified. Gill suggests that if the system approach predicts negative outflows, in which case the discharge would go upstream, then there must be something wrong with the method in which the system approach was used. (Carrol-FRC)
W82-03204

**THE LINEAR DECISION RULE (LDR) RESERVOIR PROBLEM WITH CORRELATED INFLOWS. I. MODEL DEVELOPMENT,**
Wisconsin Univ.-Madison. Dept. of Civil and Environmental Engineering.
E. F. Joeres, G. J. Seus, and H. M. Engelmann.
Water Resources Research, Vol 17, No 1, p 18-24, February, 1981. 16 Ref.

Descriptors: *Flow control, *Reservoir releases, *Model studies, Linear decision rule, Streamflow, Mathematical studies, Reservoirs, *Inflow.

A chance-constrained reservoir optimization model (linear decision rule) has been extended to allow explicit consideration of correlated inflows. A decision rule including predicted flow as a state variable (predictive rule) is contrasted with the rule assuming uncorrelated monthly flows (independent rule) and the rule which uses knowledge of the upcoming period inflow (utopian or perfect hindsight rule). Previous opinions that the linear decision rule models are conservative are contrasted with the ability to make reliable release commitments with the predictive rule. The new rule consistently gives more total scheduled release. (Cassar-FRC)
W82-03237

**RELIABILITY PROGRAMMING IN RESERVOIR MANAGEMENT 2. RISK-LOSS FUNCTIONS,**
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
For primary bibliographic entry see Field 6A.
W82-03245

**FLOOD ROUTING PROGRAM,**
Howard, Needles, Tammen and Bergendoff, Orlando, FL.
B. L. Golding.
Civil Engineering (New York), Vol 51, No 6, p 74-75, June, 1981. 1 Fig.

Descriptors: *Flood routing, *Computers, Routing, *Flood control, Runoff, Storm runoff, Reservoirs, Computer programs, Detention reservoirs.

A BASIC language program is presented for routing floods through storage reservoirs or detention basins by the storage-indication working curve method. The program for doing flood routing as described follows the general hand computation procedures for reservoir flood routing - utilizing the Storage-Indication Working Curve Method or Modified Puls Method. This procedure assumes that the outflow or discharge from the basin is directly proportional to the storage in the basin. This program required the same initial input information as required by hand computation: a rating curve for the outlet pipe or structure with discharge in cfs for each successively higher water surface elevation, where the basin's water surface elevation is the head on the outlet pipe or structure; and an elevation-storage curve for the detention basin where storage is in acre-feet. Knowing these two relationships, the discharge can be computed which is the actual input to the computer. The program can be easily modified to allow direct entrance of both the rating and storage curves, thus eliminating the hand computation of the discharge-storage relationship. This program is also useful for routing major floods through the large reservoirs. An example is given which indicates all necessary input to route a typical inflow hydrograph through the Brad Creek Reservoir. Discharge through the reservoir outlet structure and storage at each discharge are determined and printed using a user specified routing time of one hour. (Baker-FRC)
W82-03286

**SIZING OF URBAN FLOOD CONTROL PONDS,**
University of the Witwatersrand, Johannesburg (South Africa). Hydrological Research Unit.
For primary bibliographic entry see Field 2A.
W82-03297

**DIVERSION OF THE RIVER NEVA,**
Technical Univ. of Denmark, Copenhagen. Inst. of Hydrodynamics and Hydraulic Engineering.
F. B. Pedersen, and J. S. Moller.
Nordic Hydrology, Vol 12, No 1, p 1-20, 1981. 5 Fig, 1 Tab, 16 Ref.

Descriptors: *Salinity, *Diversion losses, *Rivers, Water level, Mathematical models, Equations, Estuaries, River Neva, Baltic Sea, *Denmark.

The extent to which the diversion of the Neva River will influence hydrographic conditions in the Baltic Sea and the Danish inland waters was investigated mathematically. Part of the Neva will be diverted into dry regions in the southern USSR to meet an increasing demand for irrigation water. The Baltic estuary system is divided into eight subareas, each characterized by an equation for the mass, the volume, and the dynamic balance (the mixing). The proposed change in river flow is introduced into the equations, and the equations are solved with respect to changes in salinity, discharge, and layer depths in the system. For example, a 25% reduction in Neva discharge would increase salinities by 0.2 to 0.4% throughout the system. If the river diversion had been enacted 80 years ago, a 30-40% higher salinity would now exist in the Baltic Sea. The river diversion would reduce the dynamic stability of the estuary system, making the system more sensitive to changes in external forces such as variations in meteorology. The reduced stability would be caused by the combined effects of an increased salinity and a decreased upper layer depth. (Small-FRC)
W82-03304

**THE ECOLOGY OF A LAND DRAINAGE CHANNEL--I. OXYGEN BALANCE,**

University of Wales Inst. of Science and Technology, Cardiff. Dept. of Applied Biology.
E. J. P. Marshall.
Water Research, Vol 15, No 9, p 1075-1085, September, 1981. 8 Fig, 3 Tab, 26 Ref.

Descriptors: *Weed control, *Oxygen, *Drainage ditches, Diquat, Herbicides, Pesticides, Dissolved oxygen, Respiration, Aquatic plants, Photosynthesis, Thermal stratification, Ditches, Channels, Ecology.

The ecology of land drainage channels and the effect of weed control using diquat was investigated at 4 stations of varying depth (0.49-1.55 meters) and width (4.6-7.2 meters) within a drainage ditch near Goldcliff, Wales. During summer days considerable vertical differences in temperature (16-28 degrees C) were recorded. Oxygen levels were always low (less than 2 mg per liter) directly above the sediments and up to 20 mg per liter near the surface. Ratios of photosynthesis: respiration varied with the season, from greater than 1 early in the year to lower in August and September. Diquat (maximum concentration 1.0 mg per liter) applied to 2 sites reduced photosynthetic oxygen production to 2.9 g per sq meter per day compared with the control, 15.0 g per sq meter per day. Community respiration declined from 9.1 g per sq meter per day to 6.1 g per sq meter per day. The photosynthesis:respiration ratio dropped from 1.0 to 0.5 soon after spraying but returned to normal 10 days later. Production and respiration increased to normal levels within 15 days. Liquid herbicide applied to the surface of thermally stratified channels will likely remain on the surface until vertical mixing occurs during the night. If the water flows before mixing takes place, some herbicide may be lost, reducing the efficiency of the weed control program. (Cassar-FRC)
W82-03306

**STORMWATER DETENTION IN DEVELOPING WATERSHEDS,**
Espey Huston and Associates, Inc., Houston, TX.
C. B. Amandes, and P. B. Bedient.
Journal of the Environmental Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 106, No EE2, p 403-419, April, 1981. 8 Fig, 4 Tab, 17 Ref.

Descriptors: *Watershed management, *Detention reservoirs, Watersheds, Catchment areas, Drainage area, Storm runoff, Urban runoff, Reservoirs, Retention time, Water pollution control.

A simple procedure is presented for the analysis of stormwater detention storage at the planning stage of watershed development. Effects of various storage volumes on peak storm flows and sediment export were investigated for small residential areas. Impacts on the overall watershed of design rainfall frequency, land use patterns, and the volumes of detention storage provided were evaluated. An actual test watershed was studied under varying design conditions for the calculation of peak flow reductions and suspended solids. The study site was Keegans Bayou in Houston, Texas. The channel is about 7 miles long and drains an area of 12.4 square miles into Brays Bayou and ultimately to Galveston Bay. Dry weather flow is less than 5 cfs and is mainly treated sewage effluent. The lower watershed has been the site of significant urban development, while the upper watershed remains largely undeveloped. Soil in the area is primarily heavy clay falling into the soil conservation Service's Hydrologic Group D. The high runoff potential and prevailing ground slopes of less than 1% make drainage improvements necessary if flood damage is to be prevented. Using a design control level of 12 acre-ft/200 acres, the effects of detention storage on the Keegans Bayou watershed were evaluated for rainfall events of 1 and 2 inches. Results indicated that some reductions in flood peaks and sediment transport are seen with detention controls in only 14% of the developed area. Ten-fold reductions over the uncontrolled case are observed for the fully urbanized, fully controlled scenario. (Baker-FRC)
W82-03363

## 4B. Groundwater Management

**DESIGN AND ECONOMICS OF A SOLAR HEATER AQUIFER STORAGE SYSTEM,**
Texas A and M Univ., College Station. Dept. of Chemical Engineering.
S. Tostengard, W. B. Harris, and R. R. Davison.
AIChE Symposium Series, Vol 77, No 210, p 12-20, 1981. 13 Fig, 5 Tab, 8 Ref.

Descriptors: *Solar energy, *Storage, *Aquifer systems, *Heat transfer, *Energy sources, New Mexico, North Dakota, Wells, Design criteria, Economic aspects, Heated water, Groundwater management.

Storage of solar heat in aquifers is simulated for climatic conditions of central New Mexico and North Dakota. The system consists of solar heat collectors, surface storage cells, supply wells, and storage wells. Although efficiency is low in the first year while the aquifer is being heated, it can rise to over 80% after 3-5 years. In warm weather water from the supply well is withdrawn, heated, and injected into the storage well. In cold weather the flow is reversed. Hot water is pumped from the storage well, used for building heating, and injected into the supply well. Efficiency rises with aquifer thickness, with temperature of location, and with total volume. It is desirable to drill more wells (unless well costs are very high) rather than to operate wells at peak load. Surface storage is valuable at high ratios of heater area to well flow volume. With existing federal tax credits, the system is competitive with oil under most circumstances and with gas under favorable circumstances. (Cassar-FRC)
W82-03143

## 4C. Effects On Water Of Man's Non-Water Activities

**ASSESSMENT OF UPPER MISSISSIPPI RIVER FLOODPLAIN CHANGES WITH SEQUENTIAL AERIAL PHOTOGRAPHY,**
K. N. Olson.
PhD Thesis, July, 1980. 284 p, 42 Fig, 10 Tab, 108 Ref, 13 Append. University Microfilms International, Ann Arbor, MI; Order No GAX81-15024.

Descriptors: *Flood plains, *Land use, *Aerial photography, Sedimentation, Erosion, Spoil banks, *Upper Mississippi River, Environmental alteration, Mississippi River, Minnesota, Iowa.

This study was designed to determine the types and extent of natural and man-influenced changes in floodplain features in the Upper Mississippi River Valley from Minneapolis, Minnesota, to Guttenberg, Iowa, over the 35-year period following completion of the 9-foot navigation project in 1938. The following areal changes have occurred in land cover and land use: Water areas have decreased 4% within the study area due to the sedimentation in backwater areas, deposition of dredged material, and plant colonization and succession. Marsh areas have increased quite uniformly, the increase averaging 7.59% throughout the area. Meadows have decreased and forest increased due to decreased agricultural activity and lower incidence of fire. Emergent aquatics do not show a clearcut case of having uniformly increased or decreased in area. Altered flow patterns, turbidity, and the expansion of marsh vegetation have caused some areas to decrease. Sedimentation has allowed emergent aquatics to become established in other areas. Agriculture has decreased in all pools due to the raised water-tables and lowland flooding and land purchase by the federal government. Residential areas have increased slightly overall, but will probably remain static due to the pattern of federal land ownership and flooding potential. The area of disposal sites of dredged material has increased in all pools due to the continued maintenance activities of the Corps of Engineers. Due to the complexity and difficulties of field access to floodplain areas, a technique involving the comparison of sequential aerial photography is the only practical method of determining precisely and accurately the changes which have occurred over time in land and water surface areas and in land use. (Sinha-OEIS)
W82-03015

**FORECASTING SUBSURFACE WATER FLOW AND STORAGE ON FORESTED SLOPES USING A FINITE-ELEMENT MODEL,**
For primary bibliographic entry see Field 2G.
W82-03018

**COPING WITH INCREASED STREAM EROSION IN URBANIZING AREAS,**
Rutgers-The State Univ., New Brunswick, NJ. Water Resources Research Inst.
For primary bibliographic entry see Field 2J.
W82-03067

## 4D. Watershed Protection

**HOW ABOUT REVERSE FILTERS,**
Connecticut Univ., Storrs. Dept. of Civil Engineering.
C. J. Posey.
Civil Engineering (New York), Vol 50, No 4, p 78-79, April, 1980. 2 Fig, 3 Ref.

Descriptors: *Reverse filters, *Filters, *Erosion control, Sand, Fabrics, Storm drains, Waterways, Dams, Embankments.

Reverse filters may be used to control erosion in embankments and storm drains. These are constructed with the fine material below the coarse. Granular materials of the proper sizes are difficult to obtain because commercial materials have very narrow size ranges. Sometimes natural deposits of the different sized materials in the desired proportions can be found. Often 2 or 3 commercial materials are mixed as desired. Instructions for choosing grain sizes are given. Usually sand can be used for the first layer, and material directly from the rock crusher (if it does not contain too many fines) can be used to protect the sand. (Cassar-FRC)
W82-03247

**STORMWATER DETENTION IN DEVELOPING WATERSHEDS,**
Espey Huston and Associates, Inc., Houston, TX.
For primary bibliographic entry see Field 4A.
W82-03363

# 5. WATER QUALITY MANAGEMENT AND PROTECTION

## 5A. Identification Of Pollutants

**WATER QUALITY ANALYSES OF THE COLORADO RIVER CORRIDOR OF GRAND CANYON,**
B. M. Tunnicliff.
PhD Dissertation, 1980. 183 p, 29 Fig, 21 Tab, 25 Ref, 2 Append. University Microfilms International, Ann Arbor, MI; Order No GAX17772.

Descriptors: *Water quality, *Pollutant Identification, *Recreation, *Enteric bacteria, Bottom sediments, Hazards, Coliforms, Surface water, *Grand Canyon, *Colorado River, River runners.

Water quality analyses in Grand Canyon examined Colorado River and tributary baseline water quality status in relation to recreational float trip use of the river corridor. During the 1972 and 1979 float trip seasons, outbreaks of gastroenteritis occurred among river runners in Grand Canyon. Potentially, the Colorado River or a tributary served as a source or carrier of a pathogen, though this has not been confirmed. Water quality analyses of the Colorado River corridor occurred during the 1978 and 1979 river running seasons. Examination of the extensive river corridor necessitated analyses in the field. A total of 497 water quality samples were

collected over the two seasons. Selected microbial, physical, and chemical parameters were measured to determine baseline water quality status. Data from 1978 and 1979 show that the Colorado River and tributaries have similar bacterial water quality profiles. Surface waters show predominantly low FC densities, indicating high quality waters for recreational activities, however treatment of river and tributary surface water is necessary to assure drinking water quality standards. Bottom sediment analyses modify considerably the water quality status represented by surface water analyses alone. Significant densities of enteric organisms are present in the river and tributary environments, representing an important water quality hazard. Associated with resuspension of bottom sediments is the probability of surface water contamination by enteric organisms. Recreational activities, particularly water play in confined tributary pools, can bring river runners in direct contact with concentrated sediment suspension in surface waters. (Sinha-OEIS)
W82-03017

**1981 ANNUAL REPORT - COMMITTEE ON THE ASSESSMENT OF HUMAN HEALTH EFFECTS OF GREAT LAKES WATER QUALITY.**
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Water Quality Board.
November, 1981. 142 p, 6 Tab, 102 Ref, 1 Append.

Descriptors: *Water quality, *Chemical wastes, *Toxicity, *Hazardous materials, *Lakes, Carcinogens, Toxins, Human population, Enteroviruses, Chlorination, Industrial wastes, Monitoring, Microbiological studies, Fish populations, *Great Lakes.

The Committee's 1980 report contained a preliminary review of the toxicological data base for the chemicals listed in the 1978 Great Lakes Water Quality Board Report, and indicated those of concern from an acute and chronic toxicity perspective. The Committee reexamined the data base in 1981 and categorized the chemicals as follows: (1) those posing a threat to man from acute exposure; (2) those causing chronic effects which are subject to regulatory monitoring; (3) those causing chronic effects which are not monitored but should be considered for it; (4) those of minimal health concern; and (5) those having insufficient data to conduct a health hazard assessment. Toxicity was based on six key elements: acute toxicity, carcinogenicity, reproductive effects, heritable mutagenicity, neurobehavioral effects, and chronic adverse effects. Exposure potential, persistence in the environment, and potential for bioaccumulation were also considered in determining if a compound was of actual or potential concern. Careful monitoring and environmental surveillance, using the specific criteria outlined, are recommended to reduce the subjectivity in human health risk assessment. Microbiological monitoring should be continued to reveal trends in water quality as a result of new treatment technologies and to identify industrial byproducts discharged into the Basin. Areas of future concern, such as health impacts of energy production, methods to collect epidemiological data, and exposure to air pollutants are discussed. The appendix lists exposure and toxicity profiles of 91 chemicals found in the Great Lakes. (Atkins-Omniplan)
W82-03104

**SURVEY OF POLYCHLORINATED BIPHENYLS IN INDUSTRIAL EFFLUENTS IN CANADA.**
Environmental Protection Service, Ottawa (Ontario).
Economic and Technical Review Report EPS 3-WP-81-1, 1981. 19 p, 26 Ref, 5 Tab.

Descriptors: *Polychlorinated biphenyls, *Industrial effluents, *Sediments, *Aquatic environment, *Contaminants, Discharges, Analytical methods, Sampling, Sewage treatment plants, Pulp and paper mills, Steel plants, Aluminum smelter effluents, Chemical plants, Industrial wastewater, Canada, Pollutant identification.

A survey of polychlorinated biphenyls (PCBs) in industrial effluents and process streams in Canada was conducted in two phases. Phase I was an overall screening study with samples taken from various industrial sectors, while in Phase II only those industrial plants identified in Phase I as discharging significant quantities of PCBs in their effluents were sampled. In Phase I, a total of 308 samples were collected and analyzed for PCB concentration. Of the 308 samples tested, 48 were found to contain more than 0.1 ppb of PCBs. Industries identified as having samples containing PCBs were: (1) those using PCBs in their products, (2) those using PCB-containing materials in the operation of equipment, and (3) those using recycled materials contaminated with PCBs in their processes. Samples containing PCBs were also obtained from a number of other industrial facilities and from sewage treatment plants. The Phase II study included sampling a total of 45 effluents from seven selected plants. The results confirmed the findings of the Phase I study. The sources of PCB contamination and the formation of PCBs as inadvertent byproducts of various operations are discussed. (WATDOC)
W82-03107

**OCCURRENCE OF RHODOCOCCUS COPROPHILUS AND ASSOCIATED ACTINOMYCETES IN FECES, SEWAGE, AND FRESHWATER,**
Leeds Univ. (England). Dept. of Civil Engineering.
D. D. Mara, and J. I. Oragui.
Applied and Environmental Microbiology, Vol 42, No 6, p 1037-1042, December, 1981. 5 Tab, 19 Ref.

Descriptors: *Bioindicators, *Feces, *Animal wastes, Microbiological studies, Indicators, Water pollution sources, Rhodococcus coprophilus, *Actinomyces, Sewage bacteria, Farm wastes, Bacteria, Pollutant identification.

Rhodococcus coprophilus was consistently isolated from animal wastes and water polluted by animal wastes but not from human feces. This actinomycete may have potential as a specific indicator organism for pollution from farm animal wastes. In examinations of 97 samples of feces, R. coprophilus was not recovered from humans, cats, rabbits, rats, mice, or turkeys. In feces from farm animals (cattle, sheep, horses, pigs, hens, ducks, and geese) R. coprophilus numbers ranged from 3900 to 2.5 million per g of feces. R. coprophilus was detected in 100% of feces samples from cattle, sheep, pigs, and horses, but not in laboratory-raised fowls. Stream water contaminated with farm wastes and raw sewage contained average R. coprophilus counts of 13,000-16,000 per 100 ml and 140 to 3700 per 100 ml, respectively. Ratios of fecal coliforms to fecal streptococci could not distinguish between human and animal feces. The ratio of R. coprophilus to total actinomycetes (0.40-0.76) was higher in feces from cattle, sheep, ducks and geese than in feces from pigs (0.43) and fowl (0.13). (Cassar-FRC)
W82-03122

**EXTRACTION-SPECTROPHOTOMETRIC DETERMINATION OF SUB-MICROGRAM AMOUNTS OF NITRITE USING 4-NITROANILINE AND NAPHTH-1-OL,**
Ravishankar Univ., Raipur (India). Dept. of Chemistry.
A. K. Baveja, J. Nair, and V. K. Gupta.
Analyst, Vol 106, No 1266, p 955-959, September, 1981. 1 Fig, 3 Tab, 13 Ref.

Descriptors: *Nitrites, Water analysis, Nitrogen compounds, *Pollutant identification, Rivers, Spectrophotometry, *Trace levels.

Trace levels of nitrite in river water were successfully determined with a method involving a two-step reaction to form an azo dye, followed by hexanol extraction and spectrophotometric measurement at 610 nm. The two-step reaction consists of: (1) reaction of the nitrite with 4-nitroaniline in the presence of 0.1 M HCl to form 4-nitrophenyldiazonium chloride, and (2) reaction of the diazonium ion with naphth-l-ol to form a purple azo dye. This dye is extracted with hexanol, which is more suitable than butanol, pentanol, isopentanol, or octanol. Absorbance is constant from 15 to 40 C and does not change more than + or - 2% up to 30 hours. The practical range for determination of nitrite by this method is 0.035-0.123 ppm. The 12 river water samples, all diluted from 4 ml to 50 ml prior to analysis, contained 0.36 to 0.83 ppm nitrite, which agreed well with results from the conventional sulfonamide-N-(l-naphthyl)-ethylenediamine dihydrochloride method. Ethylenediaminetetraacetic acid or tartrate masking agents prevented interference from a variety of ions, including Fe, Bi, and Cu. A complete table of tolerances is presented. (Cassar-FRC)
W82-03123

**CARBON ISOTOPE FRACTIONATION DURING MICROBIAL METHANE OXIDATION,**
Waterloo Univ. (Ontario). Dept. of Earth Sciences.
J. F. Barker, and P. Fritz.
Nature (London), Vol 293, No 5830, p 289-291, September 24, 1981. 2 Fig, 1 Tab, 16 Ref.

Descriptors: *Methane, *Isotope fractionation, *Bacteria, *Carbon isotopes, Methane bacteria, Oxidation, *Groundwater, Carbon dioxide.

Carbon isotope (C12:C13) ratios were investigated in mixed cultures of methane-utilizing bacteria producing CO2 from CH4. The respired CO2 was depleted in Cl2 relative to the residual CH4 by 2.96% to 0.5%, with the depletion diminishing as the CH4 content decreased. The isotopic fractionation factor varied from 1.0313 to 1.0052. The variation could not be related to temperature, rate of CH4 consumption, or variation in CH4/02 ratios. Although the experiments were carried out at higher temperatures than are found in most groundwaters, the results helped explain observations in three groundwaters from shallow aquifers on the nothern shore of Lake Erie. They all contained small, variable quantities of CH4 (0.4 to 9 cu cm at STP per liter of water). The delta C13 methane ranged from -2.98% to -3.70%. Comparing these values with biogenic methane (delta below -5.0%) and methane in underlying gas deposits (delta -3.68% to -4.44%) it is evident that the methane did not come directly from either methanogenesis or the gas deposits. A possible explanation is that the groundwater contained methane from natural gas which had been partially oxidized by bacteria. Wherever bacterial methane oxidation is posible, the carbon isotope ratio of residual methane may not be a reliable indicator of the origin of the gas. (Cassar-FRC)
W82-03188

**RNA SYNTHESIS AS A MEASURE OF MICROBIAL GROWTH IN AQUATIC ENVIRONMENTS. II. FIELD APPLICATIONS,**
Hawaii Univ., Honolulu. Dept. of Oceanography.
D. M. Karl, C. D. Winn, and D. C. L. Wong.
Marine Biology (Berlin), Vol 64, No 1, p 13-21, September, 1981. 4 Fig, 6 Tab, 28 Ref.

Descriptors: *Microbiological studies, *Aquatic habitats, Environments, Aquatic life, Eutrophic lakes, Microorganisms, Growth, Bacteria, Freshwater, Seawater, Coastal waters, Hawaii, Ribonucleic acid.

Field applications are considered of the tritium-labeled adenine technique used to study microbial growth in freshwater and marine habitats. Freshwater samples were collected from Krauss Pond, a eutrophic environment dominated by the green alga, Chlorella sp., located at Manoa. Freshwater was also collected from two prawn ponds located in Kahuku, Hawaii. Coastal seawater samples were collected from Kewalo Basin, Kaneohe Bay, on Oahu, Hawaii. Rates of stable ribonucleic acid (RNA) synthesis were calculated from time-series measurements of the uptake of tritium-labeled adenine and labeling of the intracellular adenosine triphosphate (ATP) and stable RNA pools for microbial communities. Most of the variation in total rates of microbial RNA synthesis was attributable to differences in microbial biomass. If total rate data are normalized to living microbial carbon

as based on ATP measurements, the variation in specific rates of RNA synthesis is decreased by a factor of 100 to 1000 for microbial communities from diverse environments. Experiments to determine the importance of light or dark conditions indicated that the uptake and incorporation of tritium-labeled adenine are uncoupled from photophosphorylation. The measurement of rates of stable RNA synthesis of microbial assemblages in nature can provide information which is helpful in studying the in situ growth rates and the response of communities to changes in environmental conditions such as nutrient additions. (Baker-FRC)
W82-03191

**RNA SYNTHESIS AS A MEASURE OF MICROBIAL GROWTH IN AQUATIC ENVIRONMENTS. I. EVALUATION, VERIFICATION AND OPTIMIZATION OF METHODS,**
Hawaii Univ., Honolulu. Dept. of Oceanography.
D. M. Karl, C. D. Winn, and D. C. L. Wong.
Marine Biology (Berlin), Vol 64, No 1, p 1-12, September, 1981. 7 Fig, 3 Tab, 31 Ref.

Descriptors: *Microbiological studies, *Aquatic habitats, Environment, Aquatic life, Eutrophic lakes, Microorganisms, Growth, Bacteria, Freshwater, Seawater, Coastal waters, Hawaii, Ribonucleic acid.

Laboratory and field experiments are described which were designed to evaluate the validity of the stable RNA synthesis technique as a probe for evaluating the growth rates of microorganisms in nature. Coastal seawater samples were collected from Kewalo Basin, Kaneohe Bay and Waikiki Beach, Oahu, Hawaii. Some samples were also taken from a eutrophic freshwater pond located on the University of Hawaii at Manoa campus. This pond, Krauss Pond, was dominated throughout most of the year by the alga Chlorella sp., and contained a high concentration of particulate organic detritus. Bacteria were frequently associated with particles larger than 5 micrometers. Additional freshwater samples were taken from aquaculture ponds on Oahu, Hawaii. Following addition of tritium-labeled adenine to water samples, microorganisms assimilate it either without any luxury uptake or without any expansion of intracellular adenine nucleotide pools. The calculated rate of stable RNA synthesis tends to be overestimated during the initial time periods of labeling due to kinetic compartmentalization of the nucleic acid precursor pool. Time series analyses decrease the effects of compartmentalization with increasing incubation. Mass-balance radioactivity inventories greatly facilitate the interpretation of nucleic acid precursor assimilation. It was concluded that independent measurements of precursor specific radioactivity are necessary for any elucidation of rates of stable RNA synthesis, and thus microbial growth, in nature. (Baker-FRC)
W82-03192

**FOSSIL CARBON IN COASTAL SEDIMENTS,**
Glasgow Univ. (Scotland). Dept. of Chemistry.
M. S. Baxter, M. J. Stenhouse, and N. Drndarski.
Nature (London), Vol 287, No 5777, p 35-36, September 4, 1980. 1 Fig, 1 Tab, 11 Ref.

Descriptors: *Carbon, *Marine sediments, *Coastal waters, Coal, Carbon radioisotopes, Fuel, *Pollutant identification, Sediments, Estuaries, Scotland, Clyde River, Firth of Clyde, Municipal wastes, Path of pollutants, Radioactive dating.

There is no radioactive carbon-14 in fossil carbon as it occurs in coal, oil, and their derivatives. If even small concentrations of fossil carbon are present within sedimentary materials, anomalously old radiocarbon ages may result. Findings of artificially high carbon-14 ages in the upper 20 centimeters of Baltic Sea sediments in correlation with increased heavy metal concentrations are consistent with the growth of industrial activity in this area. In the past, this increase in radiocarbon age has been regarded as an approximate measure of the extent of pollution of sediment organics by industrial fossil fuels. Analysis of surface sediments from the Clyde Sea area in south-west Scotland shows that natural fossil carbon contributes about 30 percent and industrial fossil fuels about 20 percent of the total carbon. These results indicate that natural fossil carbon contamination must be considered a potential and significant source of error in dating sediments. This natural component occurs at all sediment depths and, if constant, does not preclude estimation of deposition rates. However, the natural input may be added to and masked by anthropogenic releases in recent surficial samples. The two natural fossil components cannot be differentiated unless long cores are available, and considerable errors may occur in evaluating data from surface samples alone. (Carroll-FRC)
W82-03201

**GENERAL METHOD FOR DETERMINATION OF PESTICIDE RESIDUES IN SAMPLES OF PLANT ORIGIN, SOIL, AND WATER. III. GAS CHROMATOGRAPHIC ANALYSIS AND CONFIRMATION,**
Plant Protection and Agrochemistry Centre, Budapest (Hungary).
A. Ambrus, E. Visi, F. Zakar, E. Hargitai, and L. Szabo.
Journal of the Association of Official Analytical Chemists, Vol 64, No 3, p 749-768, 1981. 8 Fig, 4 Tab, 5 Ref.

Descriptors: *Pesticide residues, *Chromatography, *Water analysis, Pollutant identification, Herbicides, Insecticides.

Pesticide residue analysis methods using only one gas chromatograph in combination with thin layer chromatography and column chromatography were developed. The main criteria for the optimum method were that it be reliable, quick and usable for both screening and confirmation. Many packings of various polarities were tested. The most suitable for general purposes were OV-22 and OV-101. Others tested were NPGS, SE-30 (3% on Gas-Chrom Q), and 1.95% SP-2401/1.5 SP-2250 on Supelcoport. A study on thermionic detector performance suggested that each detector should be optimized individually. Short columns, 45-90 cm, were suitable for screening purposes. Although their resolving power was less than that of longer columns, the time of analysis was much shorter, the MDQ values with the same detector were 5-10 times lower, and lower column temperatures were possible. For confirmation of peak identities, silica gel column chromatography combined with gas-liquid chromatographic analysis on a short column proved useful. A table lists the detectability, recovery, and limit of detection for 163 pesticides. (Cassar-FRC)
W82-03215

**GENERAL METHOD FOR DETERMINATION OF PESTICIDE RESIDUES IN SAMPLES OF PLANT ORIGIN, SOIL, AND WATER. II. THIN LAYER CHROMATOGRAPHIC DETERMINATION,**
Plant Protection and Agrochemistry Centre, Budapest (Hungary).
A. Ambrus, E. Karoly, A. Fulop, and J. Lantos.
Journal of the Association of Official Analytical Chemists, Vol 64, No 3, p 743-748, 1981. 1 Fig, 3 Tab, 8 Ref.

Descriptors: *Thin layer chromatography, *Pesticide residues, *Water analysis, *Pollutant identification, Chromatography, Carbamate pesticides, Halogenated pesticides, Triazine pesticides, Urea pesticides.

The applicability of thin layer chromatography in screening pesticide residues of unknown origin was tested using several modes of detection. Most practical eluting solvents were methylene chloride and ethyl acetate. Minimum detectable quantities and retention factors are given for 99 pesticides. o-Toluidine and potassium iodide detected carbamates, ureas, triazines, and some other pesticides. p-Nitrobenzenediazonium fluoroborate selectively detected certain carbomates. Bioassay with fungi spores was useful for detection of fungicides; plant extracts did not interfere. Enzyme inhibition was affected by some natural plant materials. Silver nitrate and ultraviolet radiation nonselectively detected halogen-containing compounds and required careful sample cleanup. p-Dimethyl aminobenzaldehyde was good for all ureas and some carbamates. (Cassar-FRC)
W82-03216

**ANALYTICAL REFERENCE MATERIALS. III. PREPARATION AND HOMOGENEITY TEST OF LARGE QUANTITIES OF WET AND DRY SEDIMENT REFERENCE MATERIALS FOR LONG TERM POLYCHLORINATED BIPHENYL QUALITY CONTROL STUDIES,**
Canada Centre for Inland Water, Burlington (Ontario).
A. S. Y. Chau, and H-B. Lee.
Journal of the Association of Official Analytical Chemists, Vol 63, No 5, p 947-951, September, 1980. 3 Tab, 9 Ref.

Descriptors: *Polychlorinated biphenyls, *Sample preparation, *Lake sediments, Sediments, Sedimentology, Sample preservation, Sampling.

Preparation of large quantities of wet and dried lake sediments to be used as analytical reference materials for long term polychlorinated biphenyl (PCB) quality control studies is described. Over 500 subsamples, 15 to 20 g each, of well-homogenized and characterized, wet spiked sediment reference material were prepared. For wet samples, about 12 kg of water-saturated sediment was added to three liters of water and 150 gm concentrated HCl and blended for two minutes. For a spiked specimen, the PCB spiking solution in 10 ml of acetone is added to the slurry. This sample can be subdivided. For dry samples, sediment is frozen and then thawed in garbage cans. Water is drained out through holes during the thawing process. The sediment is then freeze-dried, crushed, screened, blended, and blotted. Homogeneity was determined for subsamples in each group. These procedures can be used to prepare wet or dry samples that are either natural or spiked with PCB. (Small-FRC)
W82-03224

**TRACE ANALYSIS OF TOXIC METALS. I. DETERMINATION OF LEAD, MERCURY, CADMIUM AND THALLIUM BY AMPEROMETRIC TITRATION,**
Singapore Univ. Dept. of Chemistry.
S. A. K. Hsieh, and T. S. Ma.
Mikrochimica Acta, Vol 2, No 3/4, p 291-300, 1980. 11 Fig, 2 Tab, 15 Ref.

Descriptors: *Heavy metals, *Metals, *Volumetric analysis, *Pollutant identification, Lead, Mercury, Cadmium, Thallium, Trace elements.

Lead, Mercury, cadmium, and thallium were determined in the microgram range by micro-amperometric titration with ethylenediamine tetraacetic acid, using a dropping Hg electrode. This method, applicable to small establishments, has a detection limit of about 1 ppm and is accurate to plus or minus 5%. Titrant volume was read by digital voltmeter to minimize human error. (Cassar-FRC)
W82-03236

**IMPROVED MICROBE DETECTION IN WATER SAMPLES.**
Public Works, Vol 112, No 6, p 134, 136, June, 1981. 1 Fig.

Descriptors: *Microorganisms, *Microbiological studies, *Filtration, *Electrochemistry, *Escherichia coli, Microscopic analysis, Experimental data, Data interpretation, Bacteria, Water sampling, Sample preparation.

Two techniques, membrane filtration and electrochemical microbial detection, are combined in a new method for detecting microorganisms in water samples. Cells are collected by the filter placed on an absorbent pad moistened with 2.0 ml of trypticase soy broth. The electrodes are positioned on the surface of the filter. The other pad, moistened with soy broth, is placed on top of the electrodes and filter. A retainer ring at right angles to the electrodes maintains constant pressure and close

contact between pads, filter, and electrodes. The dish is sealed with parafilm to reduce moisture. For Escherichia coli, favorable results were obtained with 50 estuarine and 46 water samples tested with the combined technique. Results with Staphylococcus aureus, however, were erratic and not reproducible. (Titus-FRC)
W82-03258

**SODIUM REGULATION IN THE TIDEPOOL COPEPOD TIGRIOPUS CALIFORNICUS,**
California State Polytechnic Univ., Pomona. Dept. of Biological Sciences.
P. M. McDonough, and D. F. Stiffler.
Comparative Biochemistry and Physiology. A: Comparative Physiology, Vol 69A, No 2, p 273-277, 1981. 5 Fig, 19 Ref.

Descriptors: *Copepods, *Salt balance, *Sodium, *Physiological ecology, Salinity, Crustaceans, Evaporation, Tidal marshes, Tidal flats, Saline water, Seawater, Salt tolerance.

The copepod Tigriopus californicus, which inhabits tidepool areas along rocky coasts of North America, is able to survive a wide range of salinities caused by sudden evaporation or dilution of the media. A study was conducted to see if T. californicus regulates its ionic content by examining the sodium content of whole animal samples over an external range of 0.26-1.45 M sodium. Whole body sodium content increased gradually from 0.2 to 4.0 micromoles/milligram of dry weight with increases in external salinity. Body water content remained constant at 87.5% of body weight. Mean internal levels of sodium and upper and lower limits of extracellular sodium were below the limit of conformity with the external environment. Possible sites of sodium transport were identified on the ventral sides of the copepods through silver staining methods. However, these sites did not stain in the presence of sodium-free medium, ouabain or 2,4-dinitrophenol. These findings suggest a hypoionic regulation of sodium by active transport over the salinity levels tested. (Geiger-FRC)
W82-03262

**PRECONCENTRATION OF INORGANIC MERCURY WITH AN ANION-EXCHANGE RESIN AND DIRECT REDUCTION-AERATION MEASUREMENTS BY COLD-VAPOUR ATOMIC ABSORPTION SPECTROMETRY,**
Kumamoto Univ. (Japan). Dept. of Chemistry.
I. Sanemasa, E. Takagi, T. Deguchi, and H. Nagai.
Analytica Chimica Acta, Vol 130, No 1, p 149-156, 1981. 1 Fig, 5 Tab, 17 Ref.

Descriptors: *Mercury, *Ion exchange resins, *Sample preparation, Pollutant identification, Atomic absorption spectroscopy, Water analysis, Spectroscopy.

Inorganic mercury ions present at concentrations of 5-50 ng per liter in natural water samples (500 ml) were concentrated by adsorption on 0.2 g of chloride-type anion exchange resin. An ammonium thiocyanate-nitric acid medium was used to ensure a higher oxidation state of Hg and to prevent adsorption onto the container walls. After the resin was filtered, it was transferred to a cylindrical gas bubbler containing sulfuric acid and Sn(2+) solution. The Hg ions adsorbed on the resin were reduced to metallic Hg, which was vaporized by the air stream and measured by atomic absorption at 254 nm. The maximum steady peak was observed 6 min after beginning aeration. (Cassar-FRC)
W82-03268

**FLUORIDE DETERMINATION IN WATER: AN OPTIMUM BUFFER SYSTEM FOR USE WITH THE FLUORIDE-SELECTIVE ELECTRODE,**
Victoria Univ. of Manchester (England). Dept. of Child Dental Health.
K. Nicholson, and E. J. Duff.
Analytical Letters, Vol 14, No 12, p 887-912, 1981. 1 Fig, 7 Tab.

Descriptors: *Fluorides, *Buffers, Pollutant identification, Water analysis, Potentiometers, Fluoridation, Chemical analysis, Electrodes.

TISAB III M. triammonium citrate was the best in terms of masking ability of 11 buffer systems tested in the determination of fluoride in water using the direct potentiometric electrode method. This buffer was prepared from 58 g NaCl, 57 ml glacial acetic acid, 4 g N,N,N',N'-tetraacetic acid, and 243 g triammonium citrate, adjusted to pH 5.4 with 10 M NaOH and made up to 1 liter. Al and Mg interfered, but BO2, BO3, Ca, H2BO3, and phosphate did not. Not less than 20 min, preferably 24 hours, decomplexing time should be allowed after buffer addition. A temperature of 20 C was preferable to 50 C for analysis. Deterioration on storage suggests that buffers be discarded a week, and not more than 2 weeks, after preparation. (Cassar-FRC)
W82-03269

**A NEW VOLTAMMETRIC METHOD FOR THE DETERMINATION OF SILICA TRACES IN WATER,**
Kernforschungsanlage Juelich G.m.b.H. (Germany, F.R.).
C. S. P. Iyer, P. Valenta, and H. W. Nurnberg.
Analytical Letters, Vol 14, No 12, p 921-931, 1981. 4 Fig, 2 Tab.

Descriptors: *Silica, *Water analysis, Pollutant identification, Voltammetry, Molybdate method, Drinking water, Boiler water, Seawater.

Silica traces were determined in drinking, sea, and boiler water down to the level of 6.4 micrograms per liter by preconcentration of silicomolybdate at the electrode and subsequent voltammetric determination. Ammonium molybdate (1% solution) is added to the sample solution, and the pH adjusted to 1.6 with 0.1 M HCl. After 30 min methylethyl ketone plus citrate buffer is added. The ketone suppresses the alpha form of the silicomolybdate, ensuring that all is in the beta form; the citrate buffer masks interferences from phosphate and excess molybdate. The silicomolybdate is accumulated at the electrode by adsorption at the interface by keeping the initial potential at 0.2V for 2 min and then measuring the peak height at 0.36V. The voltammetric method is more sensitive and simpler than the spectrophotometric molybdenum blue method in comparison analyses using drinking water, seawater, and boiler water. Precision is + or - 10% at a 15 microgram per liter level. (Cassar-FRC)
W82-03270

**A SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF ANIONIC SURFACTANTS AT MICROG/LITER LEVELS,**
Sydney Univ. (Australia). Dept. of Inorganic Chemistry.
S. R. Bhat, P. T. Crisp, J. M. Eckert, and N. A. Gibson.
Analytica Chimica Acta, Vol 116, No 1, p 191-193, April, 1980. 2 Tab, 4 Ref.

Descriptors: *Surfactants, *Chemical analysis, Water analysis, Saline water, Seawater, Lakes, Rivers, Freshwater, *Spectrophotometry, Photometry, Spectral analysis.

A more sensitive spectrophotometric version of a method for the determination of anionic surfactants based on the extraction of surfactant anions into chloroform as an inner-sphere complex with the bis(ethylenediamine)copper(II) cation is presented. A single extraction is required, and the method is insensitive to ionic interferences. It is applicable to fresh, estuarine and sea water samples. After extraction, 1-(2-pyridylazo)-2-naphthol and diethylamine are added, and copper(II) is subsequently determined spectrophotometrically. With a 200 ml water sample, the detection limit is 5 micrograms/liter, as linear alkyl sulfonic acids. (Baker-FRC)
W82-03289

**LEMNA (DUCKWEED) AS AN INDICATOR OF WATER POLLUTION. I. THE SENSITIVITY OF LEMNA PAUCICOSTATA TO HEAVY METALS,**
Shinshu Univ., Matsumoto (Japan). Dept. of Public Health.
Y. Nasu, and M. Kugimoto.
Archives of Environmental Contamination and Toxicology, Vol 10, No 2, p 159-169, 1981. 6 Fig, 2 Tab, 22 Ref.

Descriptors: *Duckweed, *Heavy metals, *Water pollution effects, Toxicity, Phytometers, Measurement techniques, Path of pollutants.

The indicator plant method, or phytometer method, may be used to measure the amount of a certain pollutant using a specific plant sensitive to the pollutant. This method requires many plants that are similar in size and character at the time of measurement. In order to serve as an indicator, the plant must be sensitive to the pollutants, the sample of polluted water must be easily taken into the plant, and the condition at which the plant is most sensitive must be known. The environmental conditions affecting the growth and multiplication of Lemna paucicostata (duckweed) in the presence of heavy metals were examined in order to establish a phytometer method for water pollution using the duckweed. The pH of the medium, the concentration and composition of the nutrient in the medium, and the temperature at which cultures were maintained were all found to affect the sensitivity of Lemna to heavy metals. Multiplication of Lemna paucicostata 6746 was highly sensitive to heavy metals when cultured aseptically in a Bonner-Devirian medium (pH 6.1) containing 1 percent sucrose at 25C to 30C, so that many of the heavy metals which occur as pollutants can be detected at a concentration lower than those officially permitted in Japanese waters. (Carroll-FRC)
W82-03318

**ANALYSIS OF TRACE ELEMENTS IN SEAWATER. PART II. DETERMINATION OF HEAVY METAL TRACES IN SEA WATER BY X-RAY FLUORESCENCE ANALYSIS WITH TOTALLY REFLECTING SAMPLE HOLDERS,**
Institut fuer Anorganische und Angewandte Chemie. Hamburg (Germany, F.R.).
A. Knochel, and A. Prange.
Mikrochimica Acta, Vol 2, No 5/6, p 395-408, 1980. 5 Fig, 4 Tab, 6 Ref.

Descriptors: *X-ray fluorescence, *Heavy metals, *Seawater, Water analysis, Trace elements, Performance evaluation, Pollutant identification.

X-ray fluorescence analysis (XFA) was used to determine many trace elements in seawater using the methods developed in the GKSS-Forschungszentrum, Geesthacht. A special sampling device for deep seawater was used to collect samples in the Baltic Sea. The samples were worked up and analyzed directly on board or were acidified and preserved for analysis in the laboratory. A small chromosorb column was used to separate the elements Fe, Co, Ni, Cu, Zn, Hg, and Pb from the sea-salt matrix as the dithiocarbamates. Then, the heavy metal complexes were eluted with chloroform. Aliquots of the eluate yielded suitable measuring samples for the XRF apparatus. This procedure had detection limits 2 to 3 orders of magnitude better than conventional systems. Also, the reproducibility of results was about 10%. Purity criteria and sources of contamination were discussed for every step of the analytic procedure. (Small-FRC)
W82-03333

**ALPHA-PARTICLE RADIOACTIVITY OF HOT PARTICLES FROM THE ESK ESTUARY,**
Institute for Marine Environmental Research, Plymouth (England).
E. I. Hamilton.
Nature (London), Vol 290, No 5808, p 690-693, April 23, 1981. 3 Fig, 2 Tab, 21 Ref.

Descriptors: Radioactivity, *Estuaries, *Esk estuary, *Radioactive wastes, Effluents, Estuarine environment, Coasts, Irish Sea, Particulates, *Sediments, Aquatic life.

Studies of the sediment and biota of the Esk Estuary indicate the presence of transuranium radionuclides, which are found in the effluents discharged into the north-east Irish Sea at the Windscale nuclear fuel processing plant, 10 km to the north. Suspended particulate debris samples at the sea surface, bottom sediments and some forms of biota were collected for study in September of 1977. Methods of analysis used in this study were a new dielectric alpha-track detector, CR-39, in association with conventional chemical separation techniques, and alpha-particle spectrometry using surface barrier detectors. Analyses revealed fewer hot particles in buried sediments than in the top 10 cm of sediments, and lower specific activity. Data for Fucus vesiculosus indicates some degree of Pu enrichment. Significant levels of short-lived nuclides were found in undisturbed sediments of the Esk estuary. Dissolution of the hot particles in the Esk is aided by interactions with freshwater and flocculation processes which occur at the salt-freshwater interface. The hot particles associated with particulate water sampled at the sea surface, and thus available for transfer to marine aerosols, have a mean particle diameter suitable for entry into the human lung. (Baker-FRC)
W82-03345

**SEPHADEX LH-20 CHROMATOGRAPHY OF EXTRACTS OF MARINE SEDIMENT AND BIOLOGICAL SAMPLES FOR THE ISOLATION OF POLYNUCLEAR AROMATIC HYDROCARBONS,**
National Marine Fisheries Service, Seattle, WA. Northwest and Alaska Fisheries Center.
L. S. Ramos, and P. G. Prohaska.
Journal of Chromatography, Vol 211, No 2, p 284-289, July 3, 1981. 3 Fig, 1 Tab, 13 Ref.

Descriptors: *Hydrocarbons, *Marine sediments, *Chromatography, Marine environment, Tissue analysis, Chemical interference, Crabs, Polynuclear aromatic hydrocarbons.

A two-step procedure is described to isolate polynuclear aromatic hydrocarbons (PAHs) from extracts of sediments and tissues from the marine environment. The procedure combines silica gel chromatography and Sephadex LH-20 chromatography using contaminant-free solvent systems that are safer than benzene. The relatively simple gas chromatograms of PAH fractions isolated by this procedure permit direct quantitation. The gas chromatographic analysis of the unsaturated hydrocarbon fraction of both a sediment extract and a crab hepatopancreas extract following silica gel chromatography revealed a substantial number of compounds that coelute with PAHs and thus interfere with their determination. These interfering large polysaturated aliphatic hydrocarbons were removed on a Sephadex LH-20 column. The method yielded high PAH recoveries and eliminated the need for mass spectrophotometric techniques to separate target compounds from coeluting compounds. (Small-FRC)
W82-03370

**CHELATING RESIN CATCHER FOR CAPTURE, PRECONCENTRATION AND DETERMINATION OF TOXIC METAL TRACES (ZN, CD, HG, PB) IN WATERS (CAPTEUR DE RESINE CHELATANTE POUR LE PRELEVEMENT LA PRECONCENTRATION ET LA DETERMINATION DE METAUX TRACES TOXIQUES (ZN, CD, HG, PB) DANS LES EAUX,**
Tours Univ. (France). Lab. de Chimie Minerale et d'Hydrologie.
F. Clanet, R. Deloncle, and G. Popoff.
Water Research, Vol 15, No 5, p 591-598, May, 1981. 6 Fig, 3 Tab, 32 Ref.

Descriptors: *Heavy metals, *Ion exchange resins, *Chelation, Metals, Zinc, Cadmium, Mercury, Lead, *Pollutant identification, Chemical analysis, Water analysis, Water sampling, Sample preservation.

Trace metals at the microgram per liter level may be concentrated without alteration using a field collector. The apparatus consists of a Lexan cylindrical capsule 29 mm in diameter and 10 mm thick, containing Chelex 100 chelating resin. The collector is connected with a detachable filtering apparatus, and the sample water is percolated through. A 1-liter water sample is acidified to pH 1 with concentrated nitric acid and filtered through a 0.45 micrometer membrane. This solid residue is examined by x-ray fluorescence spectrometry. To the filtrate is added 100 ml of soda-citrate buffer and NaOH to change the pH to seven. This solution is percolated through the Chelex-100 resin collector at 1.5 ml per min. The toxic metals (Zn, Cd, Hg, Pb) are eluted with 2 M nitric acid and determined by atomic absorption spectrophotometry or anodic stripping voltammetry or by drying and pelletizing the resin and examination by x-ray fluorescence spectrometry or activation analysis. (Cassar-FRC)
W82-03379

**GROUND WATER MONITORING: PART II,**
For primary bibliographic entry see Field 5B.
W82-03380

**PRACTICAL TECHNIQUES OF RIVER MONITORING AND POLLUTION FORECASTING, PART 1: CONTINUOUS QUALITY MONITORING AND DATA ACQUISITION,**
Anglian Water Authority (England).
D. E. Caddy, and P. G. Whitehead.
Effluent and Water Treatment Journal, Vol 21, No 9, p 407-409, 411, 414, September, 1981. 5 Fig, 3 Tab, 18 Ref.

Descriptors: *Monitoring, Pollution control, Rivers, Water quality, Measuring instruments, Data acquisition, Data processing, Forecasting, *Water pollution sources, Forecasting, *Great Ouse River basin, England.

The present article is the first in a series of three, and describes some features of the instrumentation used in the Great Ouse River basin in eastern England for monitoring and forecasting pollution. The high cost of equipment and the limited range of reliable measurements which can be made impose distinct restrictions on the use of continuous monitoring. In many cases the data obtained from monitoring networks is not fully utilized. Data handling is often inefficient, being based on recorder chart or paper tape systems, or else is performed on expensive but inflexible computer systems. A significant advance in data handling would be provided by the ability to manage and process the data automatically, thus providing data summaries and analyses for management, and to forecast water quality and flow conditions. With the availability of relatively low cost microcomputers it is now possible to develop inexpensive data management and forecasting systems which will make full use of acquired data. In general, instrument reliability can be improved by sample filtration and by automatic cleaning and self calibration of instruments. Greater use of microprocessor control can enhance reliability, and advances in this area are being studied. The modelling of real time data from flow gauges and water quality monitors is being used in operational practice. Such techniques enable operational managers to forecast flow and quality conditions and thereby assess the impact of discharges along critical reaches of rivers. (Baker-FRC)
W82-03390

## 5B. Sources Of Pollution

**A 'RANDOM WALK' SOLUTE TRANSPORT MODEL FOR SELECTED GROUNDWATER QUALITY EVALUATIONS,**
Illinois State Water Survey Div., Champaign.
For primary bibliographic entry see Field 6A.
W82-03007

**METHODS OF DISCHARGE COMPENSATION AS AN AID TO THE EVALUATION OF WATER QUALITY TRENDS,**
Geological Survey, Raleigh, NC.
For primary bibliographic entry see Field 7B.
W82-03056

**SIMULATION OF THE TRANSPORT OF ION-EXCHANGING SOLUTES USING LABORATORY-DETERMINED CHEMICAL PARAMETER VALUES,**
Illinois Univ. at Urbana. Champaign. Dept. of Civil Engineering.
A. J. Valocchi, P. V. Roberts, G. A. Parks, and R. L. Street.
Ground Water, Vol 19, No 6, p 600-607, November/December, 1981. 9 Fig, 3 Tab, 18 Ref.

Descriptors: *Solute transport, *Ion exchange, *Wastewater disposal, Fate of pollutants, Model studies, Injection wells, Groundwater pollution, Aquifer characteristics, Disposal wells, Wells, *Palo Alto area, California.

Laboratory-determined chemical parameter values (selectivity coefficient and cation exchange capacity) were successfully substituted for expensive field measurements in simulation of the transport of ion-exchanging solutes in groundwater. The model was applied to the direct injection of municipal effluents into an alluvial aquifer in the Palo Alto, California, Baylands region. Analysis of observation well logs and core samples determined porosity, bulk density, and aquifer thickness. Tracer tests with chloride in observation wells produced an approximate velocity field and dispersivity values. Incorporating the above parameter values, the model was used to predict the breakthrough of major cations at the observation wells. Observed and calculated values for sodium, potassium, magnesium, and calcium agreed well, but predicted ammonia breakthrough was earlier and at a higher concentration than observed in the field. (Cassar-FRC)
W82-03057

**INCREASING HYDROGEN ION ACTIVITY OF WATER IN TWO RESERVOIRS SUPPLYING THE SAN FRANCISCO BAY AREA, CALIFORNIA,**
California Univ., Berkeley. Dept. of Plant and Soil Biology.
J. G. McColl.
Water Resources Research, Vol 17, No 5, p 1510-1516, October, 1981. 4 Fig, 2 Tab, 26 Ref.

Descriptors: *Reservoirs, *Acidity, Water pollution sources, *San Francisco Bay area, Nitrogen oxides, Air pollution, Chemical composition, *Hydrogen ion concentration, *Hydrocarbons, Nitrous oxides.

A study was conducted to determine if changes had taken place in hydrogen ion concentration over the last 25 years in untreated water of two reservoirs in different watersheds supplying the large, urban complex of the San Francisco Bay area. While no direct link between the chemical characteristics of atmospheric precipitation and reservoir waters can be drawn from the available data, changes in reservoir waters might well be related to broad trends in atmospheric pollution or to other causes such as changes in land use practices. The two Sierra Nevada reservoirs studied were the Pardee and Hetch Hetchy. Weekly measurements taken at the two reservoirs indicate increases in hydrogen ion concentrations during this time period. Based on linear models, the rate of increasing hydrogen ion concentration was the same at both reservoirs and varied concomitantly from year to year. This suggests a common, general cause for the increase. The most likely cause appears to be the increased acidity of atmospheric depositions, especially those resulting from emissions of nitrous oxides by automobiles. Both watersheds are large, and while there have been localized disturbances within each such as mining and logging, these have had only minor effects on the composition of the reservoir waters. It may also be suggested that the increases resulted from carbonic acid, a product of the emission of carbon dioxide from combustion of fossil fuels. However, the magnitude of acidity increase in the reservoirs renders this conclusion unlikely. (Baker-FRC)
W82-03081

**TRANSPORT OF ION-EXCHANGING SOLUTES IN GROUNDWATER: CHROMATO-**

GRAPHIC THEORY AND FIELD SIMULATION,
Stanford Univ., CA. Dept. of Civil Engineering.
A. J. Valocchi, R. L. Street, and P. V. Roberts.
Water Resources Research, Vol 17, No 5, p 1517-1527, October, 1981. 13 Fig, 2 Tab, 24 Ref.

Descriptors: *Groundwater movement, *Model studies, Simulation, *Solute transport, Chromatography, *Ion exchange, Chromatography, Case studies.

This paper presents an analytical framework based upon the theory of chromatography which permits a priori characterization of certain key concentration profile features. The cases studied include both homovalent and heterovalent exchange in binary and ternary systems. In order to test its validity, the chromatographic analysis is applied to a field project involving direct injection of advanced treated municipal effluent into an aquifer. All of the major features observed in the available field data are accurately predicted by the chromatographic theory. While only binary and ternary systems were considered, it is suggested that many multispecies problems could often be approximated by two or three major components. The close agreement achieved between the simulated and the actual breakthrough curves also indicates that laboratory-determined chemical parameter values can be used in field-scale transport simulations, if the hydrologic and hydrodynamic parameters are chosen to simulate reliably the movement of a conservative tracer. In applying the simulation model to a field transport problem it is anticipated that the most troublesome and expensive effort will be devoted to estimating values of velocity and dispersivity. One drawback of the analysis as presented here is that it provides no information regarding the time required for the theoretical concentration profiles to develop. (Baker-FRC)
W82-03082

EFFECTS OF CLEARCUTTING AND SLASH-BURNING ON STREAM TEMPERATURE IN SOUTHWESTERN BRITISH COLUMBIA,
British Columbia Univ., Vancouver. Faculty of Forestry.
For primary bibliographic entry see Field 5C.
W82-03087

MOLECULAR DIFFUSION AND THE SEDIMENTARY ENVIRONMENT: RESULTS FROM THE IN SITU DETERMINATION OF WHOLE SEDIMENT DIFFUSION COEFFICIENTS,
Dalhousie Univ., Halifax (Nova Scotia). Dept. of Oceanography.
For primary bibliographic entry see Field 2J.
W82-03091

CADMIUM IN GAMMARIDAE (AMPHIPODA: CRUSTACEA) OF THE RIVERS WERRA AND WESER: GEOGRAPHICAL VARIATION AND CORRELATION TO CADMIUM IN SEDIMENTS,
Oldenburg Univ. (Germany, F.R.).
G. P. Zauke.
Environmental Pollution, Series B, Vol 2, No 6, p 465-474, 1981. 3 Fig, 3 Tab, 21 Ref.

Descriptors: Sedimentation, *Cadmium, Rivers, *Sediments, Amphipods, Path of pollutants, *Crustaceans, Gammarus, *Werra River, *Weser River, Germany.

The geographical variation of cadmium in Gammarus tigrinus is evaluated as a pre-condition for monitoring the availability of this metal for an important component of the food web of the rivers Werra and Weser. Cadmium concentrations in sediments were analyzed using different sediment fractions and extraction techniques. The animals were collected from stones beneath the water surface so as to ensure comparable environmental conditions. A comparison of the cadmium concentrations in sediment obtained by the application of two different extraction procedures indicates a good agreement between the results. Distinct geographical variations of cadmium in G. tigrinus from the two rivers are a precondition for the study of the availability of cadmium to the organisms within the river system. Since cadmium levels in the sediments may be regarded as an expression of the environmental cadmium supply, the investigation of correlations between cadmium in amphipods and in sediments provides information on cadmium available to the amphipods. The algebraic value of the correlation coefficient supports the hypothesis of a linear relationship between cadmium in gammarids and cadmium in the total sediment. The algebraic value of the correlation coefficient does not support the hypothesis of a linear relationship between cadmium in G. tigrinus and cadmium in the silt fraction of the sediment. Although the relative enrichment factor found for cadmium in G. tigrinus from the river Werra indicates a slightly elevated availability of cadmium in this ecosystem, the literature survey on cadmium in other organisms shows that the rivers Werra and Weser are not highly contaminated by cadmium at present in terms of its availability to amphipods. (Baker-FRC)
W82-03094

THE STRUCTURE OF FRESHWATER HUMIC SUBSTANCES AS REVEALED BY 13C-NMR SPECTROSCOPY,
Lincoln Coll. (New Zealand).
For primary bibliographic entry see Field 2H.
W82-03095

1981 REPORT ON GREAT LAKES WATER QUALITY.
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Water Quality Board.
For primary bibliographic entry see Field 5G.
W82-03102

SALT-WATER INTRUSION IN A LAYERED COASTAL AQUIFER AT YORK POINT, PRINCE EDWARD ISLAND,
National Hydrology Research Inst., Ottawa (Ontario).
For primary bibliographic entry see Field 2F.
W82-03108

ZINC IN SEAWATER AND SEDIMENTS,
Athens Univ. (Greece). Inorganic Chemistry Lab.
M. J. Scoullos.
Water, Air, and Soil Pollution, Vol 16, No 2, p 187-207, August, 1981. 6 Fig, 5 Tab, 78 Ref.

Descriptors: *Fate of pollutants, *Zinc, *Industrial wastes, *Gulfs, Path of pollutants, Heavy metals, Water pollution, Seawater, Sediment transport, Marine sediments, Ocean circulation, Organic carbon, Oxidation-reduction potential, Seasonal variation, Aegean Sea, Mediterranean Sea, Gulf of Elefsis.

Particlate and dissolved Zn were measured for one year in sea water of the Gulf of Elefsis near Athens, Greece, and results were compared to Zn levels of other Aegean and Mediterranean Sea areas. Particulate Zn was linearly correlated with the magnetic activity of sediments. The distribution of Zn in the bottom sediments reflected the industrial pollution and its history in the Gulf. Zinc levels in sediments were comparable with those of other known polluted areas of the world, including the Severn Estuary in Britain. A deep part of the Gulf with high organic C levels and seasonal periods of anoxia also had high Zn levels, showing that the acidity of the lower part of the water column acts as a trap for Zn, depending on the seasonal circulation or redox reactions. The top 5 to 10 cm of the sediment column showed great enrichment with Zn due to the non-lattice held inorganic and, to a lesser extent, the organically bound Zn. (Geiger-FRC)
W82-03166

CHEMICAL ALKYLATION OF LEAD(II) SALTS TO TETRAALKYLLEAD (IV) IN AQUEOUS SOLUTION,
Canada Center for Inland Waters, Burlington (Ontario).
I. Ahmad, Y. K. Chau, P. T. S. Wong, A. J. Carty, and L. Taylor.
Nature, Vol 287, No 5784, p 716-717, October 23, 1980. 2 Tab, 17 Ref.

Descriptors: *Lead, *Water pollution sources, *Methylation, *Fate of pollutants, Heavy metals, Chemical reactions, Synthesis, Toxins, Water pollution, Water quality, Microbiological studies, Organic compounds.

The methylation of lead in the environment poses serious threats to water quality and aquatic life. Previous studies have proven the high toxicity of tetraalkyleads, the end products of lead alkylation. Increasing levels of inorganic lead in land waterways and sediments will increase the problem of possible lead methylation. In the belief that biological lead(II) methylation of the reactions of methyl ion donors with neutral and anionic lead compounds were initiated. The synthesis of volatile tetramethyllead and other tetraalkylleads from the reaction of lead(II) salts and other simple reagents in aqueous solution is demonstrated. Me4Pb was readily synthesized in aqueous solutions containing lead(II) salts and methyl iodide, a compound known to occur in natural waters. This finding is significant to the understanding of the chemical synthesis of toxic organoleads as well as mechanisms of microbial methylation. (Geiger-FRC)
W82-03171

ORTHOPHOSPHATE UPTAKE BY PHYTOPLANKTON AND BACTERIOPLANKTON FROM THE LOS ANGELES HARBOR AND SOUTHERN CALIFORNIA COASTAL WATERS,
University of Southern California, Los Angeles. Dept. of Biological Sciences.
D. W. Krempin, S. M. McGrath, J. B. SooHoo, and C. W. Sullivan.
Marine Biology (Berlin), Vol 64, No 1, p23-33, September, 1981. 6 Fig, 2 Tab, 57 Ref.

Descriptors: *Plankton, *Harbors, *Los Angeles Harbor, Phosphates, Bacteria, Absorption, *Coastal waters, Phytoplankton, Aquatic plants, Orthophosphates, Seasonal variation.

Sea water samples were collected 1 meter below the surface from four stations in the outer Los Angeles Harbor and one station located 1.5 km outside the harbor breakwater upcurrent of the harbor excurrent plume. Additional samples were taken at a station, SPC-15, which is 15 km offshore in the San Pedro Channel and at Station RB, 0.5 km offshore from Santa Catalina Island in Isthmus Cove. A phytoplankton-enriched size fraction was retained on a 1 micrometer pore-size filter and accounted for 83% of the total chlorophyll a but only 18% of the total bacteria. A bacterioplankton enriched size fraction passed the 1 micrometer filter but was retained on a 0.2 micrometer filter and was found to contain 82% of the total bacteria but only 17% of the total chlorophyll a. These two fractions accounted for 91 and 9% of the microbial carbon, respectively. P-33 uptake by both size fractions was inhibited by low concentrations of 2,4-dinitrophenol, N-ethylameimide, carbonyl cyanide and m-chlorophenylhydrazone. Low levels of 3-(3,4-dichlorophenyl)-1,1-dimentylurea selectively inhibited the uptake of P-33 by the plankton-enriched fraction, while valinomycin selectively inhibited P-33 uptake by the bacterioplankton-enriched size fraction. Consideration of relative surface areas of phytoplankton and bacterioplankton, their P-33 uptake rates in light and dark, and estimates of the population turnover times emphasized the potential importance of bacterioplankton in community phosphorus metabolism. (Baker-FRC)
W82-03172

UPTAKE OF VIBRIO CHOLERAE BIOTYPE ELTOR FROM CONTAMINATED WATER BY WATER HYACINTH (EICHORNIA CRASSIPES),

Johns Hopkins Univ., Baltimore, MD. Div. of Geographic Medicine.
W. M. Spira, A. Huq, Q. S. Ahmed, and Y. A. Saeed.
Applied and Environmental Microbiology, Vol 42, No 3, p 550-553, September, 1981. 2 Fig, 1 Tab, 19 Ref.

Descriptors: *Water hyacinth, *Human diseases, *Vibrio, Bacteria, Accumulation, Public health, Bangladesh, Path of pollutants.

The association between V. cholerae biotype eltor and the water hyacinth was examined under controlled conditions. The association had been noted in study of the transmission of epidemic cholera in rural Bangladesh. Tanks of 100 liter capacity that were exposed to full sunlight were inoculated and water and plant samples were removed at regular intervals. The association between the plant and contaminant was apparent after a few hours, and by five days the concentration on the plants was 300-fold greater than that of the surrounding water. This is the time period of concern, as almost 80% of detectable cholera infections occur within six days of the index case. Water hyacinth is not eaten by people, but it is free-floating and may be a vehicle for the transmission of V. cholerae biotype eltor through waterways of cholera endemic regions such as Bangladesh. (Small-FRC)
W82-03179

**ARSENO-SUGARS FROM BROWN KELP (ECKLONIA RADIATA) AS INTERMEDIATES IN CYCLING OF ARSENIC IN A MARINE ECOSYSTEM,**
Western Australian Marine Research Lab., North Beach.
J. S. Edmonds, and K. A. Francesconi.
Nature, Vol 289, No 5798, p 602-604, February, 1980. 2 Tab, 16 Ref.

Descriptors: *Arsenic, *Kelps, *Fish, *Lobsters, Sugars, Marine environment, Foods, Fate of pollutants, Metabolism, Food chains.

Two main arsenical constituents of the brown kelp, Ecklonia radiata, were isolated and identified. Interest in this study was stimulated by the high concentration of arsenic in edible sea animals, which cannot be attributed to seawater arsenic levels. Arsenic is present as arsenobetaine in the western rock lobster and the school whiting. Ecklonia is the major organism that concentrates arsenic in the coastal ecosystem of the western rock lobster and school whiting. The two main arsenical constituents of the kelp were 2-hydroxy-3-sulfopropyl-5-deoxy-5-(dimethylarsenoso)furanoside and 2,3-dihydropropyl-5-deoxy-5-(dimethylarsenoso)furanoside. Each compound seems to have a beta-ribo structure for the sugar system. Evidently, Ecklonia is processing its arsenate uptake by conversion to the sugar derivatives described. (Small-FRC)
W82-03183

**REACTOR-RELEASED RADIONUCLIDES IN SUSQUEHANNA RIVER SEDIMENTS,**
Oak Ridge National Lab., TN.
C. R. Olsen, I. L. Larsen, N. H. Cutshall, J. F. Donoghue, and O. P. Bricker.
Nature (London), Vol 294, No 5838, p 242-245, November 19, 1981. 3 Fig, 2 Tab, 16 Ref.

Descriptors: *Radiation, *Rivers, Sediments, Sedimentation, Water pollution sources, Powerplants, *Nuclear powerplants, *Susquehanna River, Chesapeake Bay.

Radionuclide activities were measured in surface sediment samples collected from the Susquehanna River and Upper Chesapeake Bay in May and September 1979. The sediment area sampled by each grab was 15 to 20 cm, and the depth of sample was above 10 cm. No evidence was found in the river sediments for gamma-emitting radionuclides which would characterize a rupture of the fuel elements. Although measurable activities of cesium-137 were noted throughout the entire lengths of cores H-3, C-4, E and 14, the activity of reactor produced cesium-134 was generally confirmed within the top 10-15 cm. The deepest appearance of cesium-137 in the sediment core indicates the beginning of significant fallout in 1954, and the deepest appearance of cesium-134 indicates the beginning of significant releases from the reactors. Peaks in the radionuclide profiles may be correlated with the history of fallout or reactor releases to provide additional time stratigraphical reference levels. The reported distributions also document the fate of reactor-released radionuclides and their extent of environmental contamination in the Susquehanna-Upper Chesapeake Bay System. (Baker-FRC)
W82-03189

**PHYSIOCHEMICAL SPECIATION OF LEAD IN DRINKING WATER,**
Lancaster Univ. Bailrigg (England). Dept. of Environmental Sciences.
For primary bibliographic entry see Field 5F.
W82-03198

**241AM FROM THE DECAY OF 241PU IN THE IRISH SEA,**
Manchester Univ. (England). Dept. of Chemistry.
J. P. Day, and J. E. Cross.
Nature (London), Vol 292, No 5818, p 43-45, July, 1981. 1 Fig, 2 Tab, 20 Ref.

Descriptors: *Radioactive wastes, *Fuel reprocessing, Effluents, Americium-241, Plutonium, Sediments, Coastal waters *Irish Sea, Plumes, *Nuclear powerplants, Powerplants, Path of pollutants.

Americium-241 is a long-lived alpha-emitting nuclide which has become one of the more important marine contaminants arising from the discharge of effluents to the Irish Sea from the nuclear fuel reprocessing plant at Windscale, Cumbria. Both americium and plutonium seem to be largely retained in sediments relatively close to Windscale, and a reservoir of 241Am is building up both from direct deposition and from the radioactive decay of sedimented 241Pu. Attempts were made to estimate quantitatively the size and rate of growth of this reservoir. Using data from Windscale discharges, estimates were made of the probable sedimentary deposition of 241Am and 241Pu over the past 20 years, and calculations were then carried out of the consequent additional ingrowth of 241Am. The latter is now about 600 Ci/year, rising towards a steady state of about 1,200 Ci/year if present rates of discharge of 241Pu are maintained. The present sedimentary reservoir of 241Am is about 18,000 Ci, of which about 4,800 have resulted from 241Pu decay in situ. Measurement of the 241Pu/Pu-alpha isotope ratio in coastal sediments confirms the estimates of 241Pu deposition. Outside the Irish Sea, in the dispersal plume into Scottish waters, the observed 241Am concentration can be accounted for largely by ingrowth from the 241Pu transported in the water mass. (Baker-FRC)
W82-03199

**EFFECTS OF EUTROPHICATION ON THE INTERTIDAL ECOLOGY OF LANGSTONE HARBOUR, U.K. AND PROPOSED CONTROL MEASURES,**
Southern Water Authority, Worthing (England).
For primary bibliographic entry see Field 5C.
W82-03207

**A FINITE ELEMENT MODEL FOR THE MIGRATION OF LEACHATE FROM A SANITARY LANDFILL IN LONG ISLAND, NEW YORK - PART II: APPLICATION,**
Argonne National Lab., IL.
A. B. Gureghian, D. S. Ward, and R. W. Cleary.
Water Resources Bulletin, Vol 17, No 1, p 62-66, February, 1981. 2 Tab, 5 Fig, 20 Ref.

Descriptors: *Leaching, *Sanitary landfills, *Finite element analysis, *Groundwater, *Water pollution sources, Soil solution, Mathematical studies, Mathematical models, Mass transfer, Calibrations, Flow wells, Prediction, On-site investigations, Areal hydrogeology, *Long Island, New York.

A two-dimensional mathematical model for the migration of ground water contamination was developed. The model uses isoparametric elements, based on the Galerkin formulation and on weighting functions of nonsymmetric form, in formulating the convective-dispersive mass transport equation. The model requires the establishment of initial and boundary contaminant concentrations. In a simulation of leachate migration from a sanitary landfill in Long Island, New York, the chloride ion was chosen as the dispersion tracer, since it is relatively free of chemical reactions which could influence the simulation. Sampling data and extrapolations of chloride concentrations measured from nearby wells were used in the simulation. The model parameters derived in the calibration of the model provided good agreement with the observed field concentrations in the verification period. Further research is necessary to rigorously define the optimal weighting in transient simulations. (Titus-FRC)
W82-03220

**THE PHOSPHORUS CYCLE IN GERMINSTON LAKE. 1. INVESTIGATIONAL OBJECTIVES AND ASPECTS OF THE LIMNOLOGY OF THE LAKE,**
Rand Afrikaans Univ., Johannesburg (South Africa). Research Group for Freshwater Biology.
For primary bibliographic entry see Field 2H.
W82-03234

**HYDROCARBON GEOCHEMISTRY OF THE PUGET SOUND REGION-I. SEDIMENTARY ACYCLIC HYDROCARBONS,**
Washington Univ., Seattle. Dept. of Oceanography.
R. C. Barrick, J. E. Hedges, and M. L. Peterson.
Geochimica et Cosmochimica Acta, Vol 44, No 9, p 1349-1362, 1980. 9 Fig, 3 Tab, 41 Ref.

Descriptors: *Sediments, *Hydrocarbons, Aliphatic hydrocarbons, *Puget Sound, *Washington, Sediment-water interfaces, Interfaces, Plankton.

Sediment cores were collected at 23 sites within the inland marine waters of northwestern Washington State in efforts to determine the origins, pathways, and fates of hydrocarbon contamination in the relatively uncontaminated modern coastal environment. Aliphatic hydrocarbon compositions were determined for 79 samples during 1975 and 1976 at 23 mid-channel stations. The top and bottom 2 cm sections were analyzed to determine geographic hydrocarbon distributions and compositional trends. Five additional cores were subsampled at a greater number of depth intervals to provide detailed vertical profiles. A predominant assemblage of primarily odd-numbered high molecular weight n-alkanes derived from the leaf waves of vascular land plants was among the groups of acyclic hydrocarbons noted in the sediment samples. Also found was a suite of naturally-derived fossil hydrocarbons which includes regular C15, C16, C18 and C20 isoprenoid alkanes and n-alkanes over the range n-C14 to n-C35. Although the origin of this particular assemplage of hydrocarbons is not known, it is second in abundance only to the plant wax n-alkanes in Puget Sound sediments. An assemblage of plankton-derived hydrocarbons such as pristane, phytadienes, n-C15 and n-C17 was also found. The low concentrations of these suggest that plankton remains may be rapidly and preferentially destroyed near the sea-sediment interface. The final resolved assemblage consisted of seven different multibranched C20 and C25 compounds, which probably have a common, but as yet unknown, origin. As unresolved complex mixture of anthropogenic hydrocarbons was also noted to be prevalent in most sediments deposited since 1875. (Baker-FRC)
W82-03241

**A SYSTEMS MODEL OF STREAMFLOW AND WATER QUALITY IN THE BEDFORD OUSE RIVER SYSTEM -- II. WATER QUALITY MODELLING,**
Institute of Hydrology, Wallingford (England).
P. Whitehead, B. Beck, and E. O'Connell.
Water Research, Vol 15, No 10, p 1157-1171, October, 1981. 12 Fig, 3 Tab, 42 Ref.

Descriptors: *Water quality, *Stochastic processes, Mathematical studies, Probabilistic process, Monte Carlo Method, Model studies, *Bedford Ouse River, Effluents, Telemetry, Remote sensing, Monitoring, Data processing, *United Kingdom, *Water management.

Water quality modeling is discussed as it relates to the Bedford Ouse Study. In order to assess the likely impact of effluent on the river system and the operational management problems that may thereby arise, dynamic stochastic models of water quality were developed. Realistic dynamic water quality models were seen to be feasible for nontidal river systems. In particular the models described provided a potentially useful and computationally efficient characterization of the flow and water quality phenomena in a river, a characterization which explained the dynamic behavior of chloride, nitrate, dissolved oxygen, and biological oxygen demand and so provided a firm foundation on which to base the investigation of other water quality states. The particular utility of time series analysis techniques was also demonstrated for the identification and estimation of water resource models. The techniques have been applied to a wide range of models from the purely black-box rainfall-runoff models, multivariable 'grey box' models of water quality, to the more detailed differential equation models of water quality. The extended Kalman filter (EKF) and Instrumental Variable methods of recursive estimation provided a powerful general method of data processing well suited to the sort of modelling problems encountered by hydrologists, water quality and water resource engineers. The models presented are intended for use mainly by management. (Baker-FRC)
W82-03243

**MICROBIAL ACTIVITY OF TRENCH LEACHATES FROM SHALLOW-LAND, LOW-LEVEL RADIOACTIVE WASTE DISPOSAL SITES,**
Brookhaven National Laboratory, Upton, NY.
A. J. Francis, S. Dobbs, and B. J. Nine.
Applied and Environmental Microbiology, Vol 40, No 1, p 108-113, July, 1980. 2 Fig, 5 Tab, 12 Ref.

Descriptors: *Radioactive wastes, *Microorganisms, *Leachates, Microbial degradation, Degradation, Bacteria, Methane bacteria, Denitrification, Anaerobic conditions, Aerobic bacteria, Bacillus, Pseudomonas, Citrobacter, Clostridium.

The abundance, distribution, and growth of microorganisms in waste leachates containing a variety of radionuclides and organics are described so as to begin to evaluate the role of microorganisms in the transformation of radioactive wastes. Water samples were collected from trenches at the disposal sites of Maxey Flats, Kentucky; West Valley, New York; Sheffield, Illinois; and Barnwell, South Carolina. Among the several aerobic and anaerobic bacteria isolated, only Bacillus sp., Pseudomonas sp., Citrobacter sp., and Clostridium sp. were identified. Mixed bacterial cultures isolated from the trench leachates were able to grow anaerobically in trench leachates, which indicates that the radionuclides and organic chemicals present were not toxic to these bacteria. Changes in concentrations of several of the organic constituents of the waste leachate samples were observed due to anaerobic microbial activity. Growth of a mixed culture of trench-water bacteria in media containing a mixture of radionuclides, Co-60, Sr-85, and Cs-134/137, was not affected at total activity concentrations of 260 and 2700 pCi/ml. The finding of active microflora in the trench leachates strongly suggests that they may play a significant role in the transformation of radionuclides and the organic constituents of the waste and thus affect the long-term storage, mobility, and migration of radionuclides from the waste disposal sites into the biosphere. (Baker-FRC)
W82-03261

**GROUNDWATER CONTAMINATION BY CHLORINATED HYDROCARBONS: CAUSES AND PREVENTION,**
Environmental Protection Agency, Philadelphia, PA.

For primary bibliographic entry see Field 5E.
W82-03300

**COMMUNITY METABOLISM OF ADENYLATES BY MICROHETEROTROPHS FROM THE LOS ANGELES HARBOR AND SOUTHERN CALIFORNIA COASTAL WATERS,**
University of Southern California, Los Angeles. Dept. of Biological Sciences.
S. M. McGrath, and C. W. Sullivan.
Marine Biology (Berlin), Vol 62, No 2/3, p 217-226, May, 1981. 5 Fig, 3 Tab, 41 Ref.

Descriptors: *Seawater, *Plankton, Harbors, Coastal waters, Adenosine, Triphosphate, *Carbon cycle, Eutrophication, Nutrients, *Los Angeles, California.

Adenylates are considered good model compounds for studying carbon cycling in aquatic ecosystems because of their high uptake by microheterotrophs, stability in seawater, and ease of measurement. Identification was made of fluxes and compartments involved in the cycling of total adenylates by a planktonic seawater community. Cell number, biomass and uptake rates for natural microbial populations were measured at in situ substrate concentrations to estimate heterotrophic activity. Seawater was sampled from a depth of 1 meter at intervals, monthly to quarterly, from four stations within the Los Angeles Harbor and from one station about 1.5 km outside the harbor breakwater in San Pedro Channel. The natural concentration of dissolved total adenylates (TA) in coastal seawater had a mean value of 2.8 nmol TA/liter. Within the harbor the specific uptake rate at normal TA concentrations varied 10-fold, from 0.028 in December to 0.28 in August. Half-saturation constant values always exceeded the natural TA concentrations in any given month, and were greater in the harbor than in the channel. Assuming a steady-state condition for the dissolved adenylate pool, a model is proposed in which losses from this pool are balanced by inputs to the pool through inefficient feeding, lysis and decomposition of particulate adenylates. Adenylate input from sewage and activated sludge processing. High adenylate pool input is seen during the summer algal bloom periods. (Baker-FRC)
W82-03301

**STUDY OF THE EXPERIMENTAL CONTAMINATION OF THE MARINE PHANEROGAM POSIDONIA OCEANICA (L.) DELILE BY MERCURY COMPOUNDS I. MODALITIES OF THE CONTAMINATION BY MERCURY CHLORIDE. (ETUDE DE LA CONTAMINATION EXPERIMENTALE DE LA PHANEROGAME MARINE POSIDONIA OCEANICA (L.) DELILE PAR LES COMPOSES MERCURIQUES: PARTIE I-MODALITES DE LA CONTAMINATION PAR LE CHLORURE MERCURIQUE,**
Aix-Marseille-2 Univ. (France). Lab. de Biologie Marine.
G. Cristiani, R. Gassend, and H. Augier.
Environmental Pollution (Series A), Vol 23, No 2, p 153-162, October, 1980. 2 Fig, 1 Tab, 14 Ref.

Descriptors: *Path of pollutants, *Mercury, *Marine flora, Accumulation, Industrial wastes, Biomagnification, Laboratory studies, Posidonia, Ecosystems, Chemical spills.

Mercuric chloride contamination in the case of a simulated accidental pollution was studied in controlled laboratory in vitro cultures of the fragile marine phanerogam, Posidonia oceanica (L.) Delile, collected near Carry-le-Rouet, France. Atomic absorption spectroscopy showed that rhizomes and especially leaves had a very high capacity for mercury concentration, but with different patterns. The mercury concentration in Posidonia changed with time and depended on the amount of Hg in the culture medium. After a variable time in the water with the initial Hg concentration, the Posidonia released part of the mercury they initially took up into the culture medium. Some physiological and histological disorders were also recorded in the most polluted aquaria. The very high concentration rate of Hg by Posidonia leaves makes these plants very dangerous sources of mercury pollution for numerous marine organisms, especially first-level consumers in the trophic chain. The results cannot be applied to natural media, where concurrent or synergistic operation of physical, chemical and biological factors modify Posidonia behavior. The results indicate the need to study the behavior of Posidonia under chronic pollution, which often occurs in nature, and to test other mercury compounds and the cytological, histological and biochemical changes caused by different types of mercury pollution. (Hertzoff-FRC)
W82-03312

**SIMULATION OF FLOW PATTERNS AND ION-EXCHANGE IN SOIL PERCOLATION EXPERIMENTS. PART II. ION-EXCHANGE PROCESSES,**
Central Inst. for Industrial Research, Oslo (Norway).
N. Christophersen, and H. M. Seip.
Water, Air, and Soil Pollution, Vol 14, p 159-170, 1980. 6 Fig, 1 Tab, 28 Ref.

Descriptors: *Adsorption, *Ion exchange, *Percolation, Model studies, *Path of pollutants, Organic matter, Chelation, Humic acids, Heavy metals, Chemical reactions, Metals, Copper, Lead, Zinc, Cadmium, Magnesium, Calcium, Hydrogen ion concentration, Mathematical models, Soil water movement, Laboratory studies.

The ion exchange processes in raw humus were studied in the laboratory and by simulation analysis. Solutions of sulfuric acid, nitric acid, hydrochloric acid, and sodium chloride, all at 0.01 N, were percolated through 4 cm thick humus samples at a rate of 1 mm per min. The cation-exchange reactions were the most significant processes for the chemical composition of the runoff. Only 1 out of 4 models tried gave results consistent with the laboratory observations. This model has 5 independent parameters and consists of first and second order chemical processes. This is a tentative model, and variations in initial parameter values greater than an order of 2 or 3 produce poor performance. Further experimental work is necessary to confirm the reaction rates, which are slower than those obtained from previous work. Since the curves' minima life within the pH range encountered in natural systems, a small change in pH could affect the solubility and availability of metal ions. The humic acid component can be dominant in systems high in organic matter. (Cassar-FRC)
W82-03335

**MAJOR EVAPORITE DEPOSITION FROM GROUNDWATER REMOBILIZED SALTS,**
Institute of Geological Sciences, London (England). Geochemistry and Petrology Div.
J. E. Rouse, and N. Sherif.
Nature (London), Vol 285, No 5765, p 470-472, June, 1980. 2 Fig, 10 Ref.

Descriptors: *Groundwater movement, *Salts, *Deposition, Saltation, Brines, Sedimentation, Surface-groundwater relations, Coastal waters, Sulfur, Sediments, Aquifers, *Libya, *Gulf of Sirte, Evaporation, Geohydrology.

The physiography and the sedimentary pattern of the western coastal plain of the Gulf of Sirte was formed by two major transgressive events. Coastal sabkhas developed behind a barrier-ridge complex following sea level rises during the late Pleistocene age, when a barrier island and lagoon were formed, and during the Flandrian transgression, when the sea reached its present level and a second, outer lagoon was established. Isolation of the coastal lagoons by a seaward sand ridge followed the stabilization of the sea level, resulting in the formation of isolated basins in which evaporites have been and are being deposited. A sulfur isotopic study was conducted to determine the sources of the brines being deposited in the sabkhas. This study demonstrated that the extensive supply of sulfur to the sabkhas originates primarily from remobilized sulfate brought to the surface and distributed into the groundwater by several

springs of sulfate or sulfate-chloride facies water. The rate of sedimentation in the lagoons is dependent on the rate and salinity of water flowing from the aquifer and on the aridity of the climate to ensure a sufficiently high evaporation rate. An extensive north-south fault and its satellite fissures provide karstic channels through which deep artesian waters from the sediments of the Upper Cretaceous reach the Miocene strata, following which the water is brought to the surface, as springs and sub-surface flow, into the groundwaters of the sabkha. Current gypsum deposition rates demonstrate the remarkably large amounts of sulfate that can be remobilized in a geologically short period of time and show that significant evaporite deposits associated with marine sediments can be formed from water derived from continental sources. (Carroll-FRC)
W82-03339

**ACIDIFICATION IN 50 NORWEGIAN LAKES,**
Oslo Univ. (Norway).
For primary bibliographic entry see Field 2H.
W82-03344

**PRELIMINARY POLLUTION SURVEYS AROUND THE SOUTH-WESTERN CAPE COAST. PART 4: SALT RIVER MOUTH, TABLE BAY,**
National Research Inst. for Oceanology, Stellenbosch (South Africa).
M. J. Orren, G. A. Eagle, A. H. Fricke, P. J. Greenwood, and H. F-K. O. Henning.
South African Journal of Science, Vol 77, No 4, p 183-188, April, 1981. 4 Fig, 7 Tab, 19 Ref.

Descriptors: *Nutrient, *Wastewater pollution, *Bacteria, Path of pollutants, *Salt River, Table Bay, *South Africa, Dissolved oxygen, Aquatic animals, Invertebrates.

Pollution surveys were conducted in the area of the Salt River, which flows into Table Bay, South Africa. In the 1975 survey, concentrations of nutrients and organics in surface water were very high in the river discharge: 15.1 micromol per cu dm total P, 57.4 micromol per cu dm silicate, 23.0 micromol per cu dm nitrite, 48.0 micromol per cu dm nitrate, and 0.026 mg per cu dm oxygen absorbed from alkaline permanganate. Comparable values for 1980 were much lower: 3.1 micromol per cu dm total P, 7.1 micromol per cu dm silicate, 4.7 micromol per cu dm nitrate, and 0.007 mg per g oxygen absorbed from alkaline permanganate. Both surface water and interstitial water samples were analyzed at 8 points between 100 and 4000 meters from the river mouth. Interstitial waters, more variable than surface waters, were higher in levels of nutrients and organic matter and were near zero, in dissolved oxygen at many sites impacted by the river discharges. Metal levels in sediments collected at these beaches were lower than at unpolluted, control beaches. The meiofaunal population was abnormal up to 4 km from the mouth; the absence of harpacticoid copepods in the first 2 km was indicative of organic pollution. There were more nematodes and harpacticoids in the next 2 km. Total bacterial counts were high, exceeding 10,000 per cu cm in the river mouth and 100 meters north of the mouth. Although the saline environment killed many coliforms, the E. coli count was 200 per 100 cu cm at 200 meters from the mouth, showing substantial sewage pollution. (Cassar-FRC)
W82-03367

**ACID PRECIPITATION IN THE PITTSBURGH, PENNSYLVANIA AREA,**
Pittsburgh Univ., PA. School of Public Health.
For primary bibliographic entry see Field 2B.
W82-03368

**SEPTIC SEWAGE SYSTEMS CONTAMINATE GROUND WATER.**
Ground Water Age, p 36-37, 40, June, 1981. 1 Fig.

Descriptors: *Septic tanks, *Groundwater pollution, Wastewater treatment, Septic wastewater, Wastewater, Water pollution sources, Wastewater renovation, Wastewater management, Wastewater facilities.

Problems and possible solutions to the use of the septic tank as an onsite wastewater disposal system are reviewed. Percolation systems such as septic systems have two basic components; the settling tank and the soil absorption field. Wastewater flows from the house to the settling tank and then to the soil absorption field. Percolation systems rely on three natural processes: filtration, biological degradation, and adsorption. When systems malfunction, wastewater can back up into the home, rise to the surface in the form of surface breakout, or short circuit and move directly into groundwater without adequate purification. Bacteria, viruses, degradable organic compounds, synthetic detergents, and chlorides may contaminate groundwater when conditions lead to failure. Nitrates can accumulate over time and result in relatively high concentrations in the groundwater as well. Systems can fail for a number of reasons. The initial setting, design, or construction could have been faulty or necessary maintenance may be neglected. The best solution to groundwater contamination lies in prevention. However, when systems have failed near urban areas, the usual solution is to abandon the onlot system and extend sewers to an existing, expanded or new treatment plant. Prevention of the problem requires comprehensive wastewater management planning and proper siting, design, construction, and maintenance of all small alternative systems. Regulations have been established concerning inspection and system design evaluation. However, maintenance is not usually a requirement. Some states are taking steps to improve the monitoring and maintenance situations. (Baker-FRC)
W82-03378

**GROUND WATER MONITORING: PART II,**
T. E. Gass.
Water Well Journal, Vol 34, No 9, p 36-37, September, 1980.

Descriptors: *Groundwater, *Monitoring, *Observation wells, Wells, Subsurface water, Groundwater pollution, Contamination, Pollutants, Borehole geophysics, Geophysics, Boreholes, Resistivity, Path of pollutants.

The use of monitoring wells to study the spread of contamination is described. Such wells may be either pumped or unpumped wells. Active monitoring involves the pumping of wells that intercept potentially contaminated ground water flow. This type of monitoring is best suited for point source contamination. Passive monitoring involves the periodic sampling of wells located in the path of ground water to determination changes in the concentrations of chemical constituents of ground water. The positioning of monitoring wells depends primarily on local hydrogeology and ground water use. All construction materials should be resistant to suspected contaminants. Sampling must be done in such a way as to minimize or eliminate sample contact with the atmosphere. Geophysical techniques used to establish monitoring wells include the borehole methods, electrical resistivity surveying, and seismic surveys. Remote sensing is also useful. (Baker-FRC)
W82-03380

**TRACE METAL SPECIATION IN THE FRESHWATER AND ESTUARINE REGIONS OF THE YARRA RIVER, VICTORIA,**
Caulfield Inst. of Tech. (Australia). Water Studies Center.
B. T.. Hart, and S. H. R. Davies.
Estuarine, Coastal and Shelf Science, Vol 12, No 4, p 353-374, April, 1981. 6 Fig, 4 Tab, 51 Ref.

Descriptors: *Trace metals, *Heavy metals, *Speciation, Metals, *Estuaries, *Yarra River, *Australia, Rivers, Chelation, Coagulation, Cadmium, Copper, Lead, Zinc, Iron, Fate of pollutants.

Speciation of trace metals was investigated at the freshwater and estuarine sites in the Yarra River, Australia. The metals Cd, Cu, Pb, Zn, and Fe were separated into the following fractions: particulate, filterable, ion-exchangeable, dialyzable, and bound. Fe was in bound and particulate form throughout the river system. Cd was predominantly in the ion exchangeable form in both river sections. Filterable Cu existed in ion exchangeable forms–organic complexes in the freshwater and either organic complexes or CuCO3 in the salt water. Pb was largely in the form of PbCO3, and Za as Zn(2+). Pb and Zn did not form appreciable complexes with organic matter. Between the freshwater and estuarine sections Fe and bound Cd were lost by coagulation. There was little change between the two sections in filterable Cu and ion exchangeable Pb and Zn. However, particulate Pb and Zn increased in the estuarine section. A strong linear relationship was seen for Fe, Pb, Zn and to a lesser extent, Cd, between the total metal and the total bound metal. (Cassar-FRC)
W82-03387

**PRACTICAL TECHNIQUES OF RIVER MONITORING AND POLLUTION FORECASTING, PART 1: CONTINUOUS QUALITY MONITORING AND DATA ACQUISITION,**
Anglian Water Authority (England).
For primary bibliographic entry see Field 5A.
W82-03390

**MATHEMATICAL MODELING AND COMPUTER SIMULATION OF RADIOACTIVE AND TOXIC CHEMICAL SPECIES DISPERSION IN POROUS MEDIA IN THE VICINITY OF URANIUM RECOVERY OPERATIONS,**
Tennessee Univ., Knoxville. Dept. of Engineering Science and Mechanics.
E. V. Kalmaz, and J. L. Barbieri.
Ecological Modelling, Vol 13, No 3, p 159-181, August, 1981. 3 Fig, 2 Tab, 54 Ref.

Descriptors: *Uranium, *Radioactive wastes, *Mining engineering, Model studies, *Mathematical models, *Path of pollutants, Fate of pollutants, Porous media, Ponds, Chelation, Adsorption, Solute transport, Groundwater pollution, Chemical precipitation, Arsenic, Radium, Thorium, Polonium.

Uranium recovery operations have great potential for releasing radioactive and toxic chemicals to surface and ground waters. About 80% of water used in mill production is lost by seepage. Holding and tailings ponds, chemical storage sites, and transportation may also be sources of contamination to water. Contaminants associated with uranium recovery are radium 226, thorium 230, lead 210, polonium 210, uranium, arsenic, iron, manganese, and sulfate. The mobility of these materials depends on the characteristics of the chemical species and/or the ions and material through which the solution migrates. Oxidized uranium compounds, likely to occur in acid solutions, are extremely mobile. Thorium activity decreases at greater distances from tailings ponds as a result of sorption and coprecipitation with metal oxyhydroxides. Polonium, very stable in the Po(4+) state in solution, is also removed from the system by adsorption or coprecipitation with metal hydroxides. Radium, which forms few complexes, occurs mostly in solution as Ra(2+) ion and precipitates with sulfate. Lead forms several stable complexes and precipitates as the sulfate and carbonate. Arsenic acid (H3As04) is the most common as species in tailings ponds. Iron and manganese oxyhydroxides are active in removing other trace metals from solution. A mathematical model is used to simulate the hydrodynamic dispersion, migration, and prediction of movement for pollutants in supersaturated porous earth. The impacts on water quality associated with in-situ uranium mining, as compared with open pit and underground mining, are more serious. In addition, migration of toxic materials of this type is favored by acidic soils, anaerobic conditions, waterlogged soils, disturbed soils, and coarse soils. (Cassar-FRC)
W82-03392

**KINETICS OF PHENOL OXIDATION BY WASHED CELLS,**
University Coll. of Swansea (Wales). Dept. of Chemical Engineering.

For primary bibliographic entry see Field 5D.
W82-03399

## 5C. Effects Of Pollution

**WATER QUALITY AND MANGROVE ECOSYSTEM DYNAMICS,**
Rosenstiel School of Marine and Atmospheric Science, Miami, FL.
S. C. Snedaker, and M. S. Brown.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-204109, Price codes: A05 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S4-81-022, August, 1981. 5 p, 1 Fig.

Descriptors: *Water quality, *Mangrove swamps, *Water pollution effects, *Model studies, Heavy metals, Copper, Ecosystems, Dynamics, Sulfates, Nitrates, Tidal effects, Flushing, Flooding, Pesticides, Runoff, Powerplants, Agricultural runoff.

Many of the ecological and physiological mechanisms that permit the mangrove ecosystem to thrive in intertidal coastal environments that are influenced by freshwater inflow from upland areas are poorly understood. From surveys of mangrove stands, it was found that mangrove ecosystem dynamics could not be related to current theory. The poorest mangrove forest development occurs in arid climates with relatively little ground water or freshewater inflow, and in sedimentary carbonate environments. Highly developed forests occur where tidal amplitude and freshwater inflow assure frequent and extensive inundation and flushing. Synthetic organic pesticides were never found in water, sediment, or plant tissues, but low to moderate concentrations of heavy metals were ubiquitous. Heavy metals were concentrated in sediments and plant tissues. Highest concentrations of metals were associated with fossil-fuel burning power plants, agriculture, and highway runoff. Nitrate and sulfate are key components of water and sediments required for development of mangrove. Nitrate may be most important as an oxidant in anaerobic decomposition of reduced organic matter accompanied by release of nutrients to the rhizosphere and the formation of ammonia. Sulfate appears to act as an oxidant that penetrates deeply into anaerobic sediments during flushing. It can also combine with metals, making them unavailable for uptake by mangroves. A model for the pathway, storage, uptake, and turnover rates of copper is given as an example of the dynamics of a pollutant as it relates to the dynamics of a mangrove ecosystem. (Moore-SRC)
W82-03003

**AN AERIAL TECHNIQUE FOR ASSESSING THE IMPACT OF COOLING WATER DISCHARGES ON RECEIVING WATER,**
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse.
For primary bibliographic entry see Field 7B.
W82-03016

**HISTOPATHOLOGICAL CHANGES IN TWO ESTUARINE FISHES EXPOSED TO CRUDE OIL AND ITS WATER-SOLUBLE FRACTIONS,**
M. A. Solangi.
PhD Dissertation, August, 1980. 93 p, 78 Fig, 4 Tab, 63 Ref. University Microfilms International, Ann Arbor, MI; Order No GAX81-09900.

Descriptors: *Water pollution effects, *Pathology, *Sublethal effects, *Oil pollution, Behavior, Mortality, *Fish, Estuaries, Crude oil, Histopathology, Chronic exposure, Hydrocarbon analysis, Menidia beryllina, Trinectes maculatus, Brackish-water fish.

Pathological changes in the liver, olfactory organ, gills, and anterior kidneys of two estuarine fishes, Menidia beryllina (Cope), and Trinectes maculatus (Bloch and Schneider), exposed to different concentrations of both whole crude oil (WCO) and its water-soluble fractions (WSF) are described. Also examined was the status of the sublethal pathological changes of exposed fish after they were returned to an oil-free environment. Results indicate that south Louisiana crude oil and at least some of its components cause sublethal to lethal pathological changes in the gills, olfactory organ and liver. Tissue alterations in these vital organs apparently induced hypoxia, reduced chemoreception, altered schooling behavior, and decreased resistance in stress. Sublethal pathological changes in the gills, olfactory organ, and pancreas such as hyperplasia and hypertrophy of gill epithelium, degenerated neurosensory and sustentacular cells, and degenerated pancreatic tissue appear to be temporary, and once fish return to an oil-free environment they have the ability to recover. Therefore, adult fish exposed to a single oil spill in the northern Gulf of Mexico, in contrast to those chronically exposed or maybe from other geographical areas, have the potential to recover from some degenerative changes. (Sinha-OEIS)
W82-03020

**COOLING WATER DISCHARGE INTO FLOODPLAIN MEADOWS AND MARSHES: EFFECTS, MECHANISMS, AND IMPLICATIONS FOR ENVIRONMENTAL ANALYSIS,**
Wisconsin Univ.-Madison.
B. L. Bedford.
PhD Thesis, 1980. 191 p, 33 Fig, 4 Tab, 212 Ref. University Microfilms International, Ann Arbor, MI; Order No GAX81-10062.

Descriptors: *Environmental effects, *Wetlands, *Flood plains, *Cooling water, Water temperature, Aquatic plants, Aquatic populations, Seasonal variation, *Thermal pollution, Powerplants.

The environmental impact statement for the Columbia Electric Generating Station raised but did not answer the question of significant change occurring in wetland plant communities on the site as a result of water leaking from the station's cooling lake. The results of research conducted on the Columbia site from 1974 to 1980 are presented. The Columbia station and associated facilities are located adjacent to and in the floodplain of the Wisconsin River. Most of the site was wetland in its preconstruction state. The major impact on wetland vegetation of discharge from the Columbia cooling lake appears to be the displacement of previously dominant populations. The extent of displacement is complete over approximately one-third of the study area, where environmental changes due to discharge have been greatest. Intermediate level changes in dominant populations have occurred over a larger area covering another third of the study site. Knowledge of the sensitivity of a community's dominant species to a disturbance is likely to provide a better predictor of response to disturbance than either community type or diversity value prior to disturbance. Unlike large open bodies of water where biological effects may be hard to detect or separate from natural variability, the effects of cooling water discharge on communities of emergent aquatic vegetation are obvious and can be monitored and measured as phenological and physiological change at the population level. Results show that species differ in their sensitivity to seasonal changes in temperature, that the mechanisms regulating population response differ among emerging aquatic species, and that relatively minor temperature changes and other environmental factors associated with increased discharge of water, and not necessarily with waste heat, can produce more subtle effects. (Sinha-EIS)
W82-03022

**WATER TEMPERATURE DYNAMICS IN EXPERIMENTAL FIELD CHANNELS: ANALYSIS AND MODELING,**
Minnesota Univ., Minneapolis. St. Anthony Falls Hydraulic Lab.
For primary bibliographic entry see Field 1A.
W82-03025

**MICROCOSMS AS TEST SYSTEMS FOR THE ECOLOGICAL EFFECTS OF TOXIC SUBSTANCES: AN APPRAISAL WITH CADMIUM,**
Georgia Univ., Athens. Inst. of Ecology.
P. F. Hendrix, C. L. Langner, E. P. Odum, and C. L. Thomas.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-209595, Price codes: A09 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S3-81-036, July, 1981. 4 p. R805860010.

Descriptors: *Toxicity, *Cadmium, *Aquatic environment, *Microcosms, *Ecosystems, Nutrients, Biomass, Environmental effects, Ecological effects.

A two-phase set of experiments was conducted to address some of the problems inherent in ecological screening of toxic substances in aquatic microcosms, and to test two hypotheses concerning the response of ecosystems to perturbations. Phase I was a 4 x 4 factorial experiment (four levels of cadmium versus four levels of nutrient enrichment) with static microcosms designed to test the subsidy-stress hypothesis. Phase II was a 2 x 4 factorial experiment (continuous and pulsed cadmium inputs versus phosphorus biomass increment hypothesis. Phase I results supported the subsidy-stress hypothesis with respect to cadmium inputs: increasing cadmium concentrations (0, 1, 10, 100 ppb) caused a decrease in the P/R ratio, a decrease in grazing herbivores, increase in nighttime respiration and fungi, all indicators of system stress. Since net daytime production and nighttime respiration increased with nutrient enrichment, there was no nutrient stress effect even at the highest level. There was a significant interaction effect of cadmium and nutrients with high nutrient levels reducing, somewhat, the stress effect of cadmium. Phase II results generally supported the biomass increment hypothesis and suggested a retention pattern for continuous, low concentration cadmium inputs similar to that of essential elements. Cadmium may have accumulated to a toxic threshold in some of the microcosms. Pulsed, high concentration cadmium inputs had significant effects on system behavior, depending on timing of inputs. For screening a suspected toxic substance, a hierarchy of microcosm experiments including static microcosms (with and without sediments), flowthrough microcosms (with and without sediments), and microcosm subsamples from specific natural ecosystems is recommended. (Moore-SRC)
W82-03026

**EPIDEMIOLOGICAL STUDIES OF OTITIS EXTERNA: REPOT OF A PROSPECTIVE AND OF A RETROSPECTIVE STUDY OF OTITIS EXTERNA AMONG SWIMMERS,**
Yale Univ., New Haven, CT. Dept. of Epidemiology and Public Health.
R. L. Calderon, and E. W. Mood.
Environmental Protection Agency Project Summary EPA-600/S1-81-053, August, 1981. 3 p.

Descriptors: *Swimming, *Water quality, *Epidemiology, *Public health, Coliforms, Pseudomonas, Staphylococcus, Bacteria, *Swimming pools.

Two epidemiological studies of otitis externa were conducted as part of a series of studies to determine if there is a direct relationship between the incidence of otitis externa and the quality of recreational water. One was a prospective study conducted in the summer of 1979 comparing boy scouts at camp who swam in a fresh water lake with boy scouts at another camp who swam in a chlorinated swimming pool. The other was a retrospective study conducted during the summer of 1980. In the prospective study, 3% of the children reported ear complaints in the week following camp, but none had otitis externa confirmed by a physician; the retrospective study compared 29 cases with 29 controls matched by sex and age. In the prospective study, a higher relative humidity at the camp where the boy scouts swam in a chlorinated pool was associated with a greater degree of abnormal flora colonization of the ear (Gram-negative bacteria and Staphylococcus aureus). In the retrospective study, positive association was demonstrated with cases of otitis externa for ambient air temperatures, water temperature, less than 18 years of age, being female, swimming, and length of time spent swimming. There was no association between cases of otitis externa and water quality as measured by fecal coliforms, enterococci, and Pseudomonas aeruginosa or between abnormal

flora colonization of the ear with bacterial indices of water quality. (Moore-SRC)
W82-03027

**RESPONSE OF PHYTOPLANKTON TO ACIDIFICATION IN EXPERIMENTAL STREAMS,**
Minnesota Univ., Minneapolis.
T. W. Weber, II.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-216822, Price codes: A04 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S3-81-042, August, 1981. 2 p.

Descriptors: *Phytoplankton, *Acidity, *Stream pollution, *Algae, *Diatoms, Species diversity, Biomass, Acid streams, Hydrogen ion concentration, Experimental data, Ecological effects.

The response of stream phytoplankton communities to acidification was studied in three experimental streams at the Monticello Ecological Research Station in Minnesota at two-week intervals from May 30 to July 11, 1979, Mississippi River water was pumped into three streams; one with an ambient pH of 8.1 and two streams maintained at pH 6.3 and 5.3 by the addition of sulfuric acid. The streams provided a unique replicate system whereby physical and chemical parameters could be controlled and continually monitored in a field situation. The density of phytoplankton in the pH 8.1 and 6.3 streams was highest during the first month of sampling, whereas, in the pH 5.3 stream it was highest in the second month. Phytoplankton density was low in all streams at the end of the sampling periods. The diversity of phytoplankton was similar throughout all three pH regimes. However, phytoplankton community similarity decreased over the course of the experimental period. Species composition was nearly identical across the pH range, dominated by diatoms in each stream. The most extreme pH value, pH 5.3, seemed to be a sublethal value for the diatoms existing there. (Moore-SRC)
W82-03036

**LAKE TROPHIC STATE AND ALGAL GROWTH AS INFLUENCED BY CATION CONCENTRATIONS,**
Science and Education Administration, Fort Collins, CO.
A. R. Batchelder.
Agricultural Research Service Technical Bulletin No 1649, November, 1981. 8 p, 2 Fig, 7 Tab, 19 Ref.

Descriptors: *Eutrophication, *Algal growth, Calcium, Magnesium, Sodium, *Cations, Standing crops, Eutrophic Lakes, Anabaena, Selenastrum, Chlorella, Trophic level, Saline water, Hardness.

Laboratory experiments were conducted to evaluate the effects of variations in the Ca, Mg, and Na concentrations in eutrophic waters on the standing crop and growth rates of three algal species; Chlorella ellipsoidea, Selenastrum capricornutum, and Anabaena subcylindrica. Each species was grown in a standard nutrient medium enriched with Ca, Mg, and Na in varying combinations and at concentrations of 2 and 8 milliequivalents per liter (meq/L) each. The dry weights of A. subcylindrica and S. capricornutum were reduced by the 8 meg/L Mg treatment but the toxic effects were overcome by adding Ca to the A. subcylindrica and Ca and Na to the S. capricornutum. None of the cation concentration variations affected the standing crop of C. ellipsoidea. The addition of Na alone to the culturesproduced little or no effect, but in combination with added Ca and Mg, it enhanced the growth rates of A. subcylindrica and S. capricornutum. Neither pH, monovalent to divalent cation ratio, or ionic strength of the media affected the algal growth. Based on data for 85 U.S. lakes that were complied from literature, concentration of 0.5 meg/L of Ca, Mg, or Na appears to be a threshold above which the lakes were usually eutrophic. Results demonstrated that Ca, Mg, and Na concentrations need to be considered as factors in saline and hard water eutrophication. (Moore-SRC)
W82-03038

**SOME ECOLOGICAL ASPECTS OF LAKE QARUN, FAYOUM, EGYPT, PART II. PRODUCTION OF PLANKTON AND BENTHIC ORGANISMS,**
Institute of Oceanography and Fisheries, Cairo (Egypt). Inland Waters and Fish Culture Div.
For primary bibliographic entry see Field 2H.
W82-03052

**OBSERVATIONS ON A GYRODINIUM AUREOLUM (DINOPHYTA) BLOOM OFF THE SOUTH COAST OF IRELAND,**
University Coll., Galway (Ireland). Dept. of Oceanography.
C. Pybus.
Journal of the Marine Biological Association of the United Kingdom, Vol 60, No 3, p 661-674, August, 1980. 7 Fig, 7 Tab, 40 Ref.

Descriptors: *Red tide, *Phytoplankton, *Ireland, Eutrophication, Nutrients, Water quality, Chemical analysis, Nitrogen, *Coastal waters, Phosphorus, Silicon.

Data collected during routine monitoring of the water quality in the vicinity of Kinsale Harbour in waters off the south coast of Ireland are presented. Sampling was performed on August 26 and 30, and September 7 and 19, with an abbreviated sampling on October 15, 1978. Surface phytoplankton samples were also collected on September 2, 5, and 12. During the sampling period the water column was generally well mixed, particularly at the seaward stations. Some stratification was apparent within Kinsale Harbour, and along the coast, reflecting the predominantly coastal flow of the River Bandon. Although several dinoflagellate and diatom species were found, only a few were common throughout the red tide. These were Gyrodinium spirale, and Oxytocum species, Prorocentrum micans, Scripsiella trochoidea, Cerataulina pelagica, Nitzschia spp., Skeletonema costatum and Thalassiosira gravida. The inorganic forms of nitrogen were all present at low concentrations at the beginning of the sampling period. By the second sampling in September these levels approached those of other coastal waters. An upward trend was noted for phosphate-phosphorus. No pattern was noted in the silicate-silicon levels. (Baker-FRC)
W82-03053

**EFFECTS OF CLEARCUTTING AND SLASHBURNING ON STREAM TEMPERATURE IN SOUTHWESTERN BRITISH COLUMBIA,**
British Columbia Univ., Vancouver. Faculty of Forestry.
M. C. Feller.
Water Resources Bulletin, Vol 17, No 5, p 863-867, October, 1981. 2 Fig, 2 Tab, 19 Ref.

Descriptors: *Stream degradation, *Water temperature, Forest management, *Logging, Watersheds, Forest watersheds, *Clear-cutting, Slashburning, Environmental effects, Stream temperature, Temperature, *British Columbia.

The effects of clearcutting and clearcutting plus slashburning on stream water temperatures were studied in paired forest watersheds in British Columbia. The predominant trees were western hemlock, western red cedar, and Douglas fir. The streams were designated A (61% clearcut), B (19% clearcut and slashburned), and C (undisturbed-control). The harvested watersheds were planted with Douglas fir seedings. Summer water temperatures and daily temperature fluctuations were increased by both treatments. However, after 6-7 years the temperature of the clearcut stream returned to its pretreatment state, whereas the clearcut plus slashburned stream showed no improvement. Although the control stream temperature never exceeded 17 C, the disturbed streams registered maximum temperatures of 21.8 and 20.3 C for A and B, respectively, and exceeded 19 C at other times. Winter temperatures recovered normal values after only 2 years. Clearcutting with slashburning had greater effects than did clearcutting alone. (Cassar-FRC)
W82-03087

**DETERGENT BUILDERS AND WATER QUALITY - A CHANGING SCENE,**
Imperial Coll. of Science and Technology, London (England). Dept. of Civil Engineering.
R. Perry.
Effluent and Water Treatment Journal, Vol 21, No 10, p 446-449, October, 1981.

Descriptors: *Water quality, *Detergents, Eutrophication, Lakes, Water pollution sources, Phosphorus, Nitrilotriacetic acid, *Zeolites, *Water pollution effects.

The current state of affairs regarding the effect of detergents on water quality is reviewed. In various studies, phosphorus has been cited as the limiting nutrient in most surface waters in the northern hemisphere with eutrophication problems. Laundry detergent is made up mainly of two ingredients: a surfactant to remove soils, and a builder to alleviate the effect of the hardness ions present in the water. The most effective builder from the formulation and performance standpoint is sodium tripolyphosphate (STPP), which was in continuous use for more than 30 years. This has become a major component of domestic sewage phosphorus loading and has attracted attention and political regulation in some countries. Utilization of alternative materials could involve vast tonnages of the products concerned. The viable alternatives, namely zeolites and nitrilotriacetic acids, are reviewed in relation to both their performance in the washing cycle and their effect with respect to water quality. Current use of zeolite in detergents worldwide now amounts to about 250 thousand tons, with about 75% of this in North America. Formulations containing zeolites require certain minimum levels of STPP; typical combinations now in use are 18% zeolite and 20% STPP. Nitrilotriacetic acid (NTA) is biodegradable under ideal conditions. However, upon a moderate change of temperature, even down to 5 degrees C, non-degraded NTA is in the position to mobilize heavy metals, forming stable complexes of cadmium and lead. The behavior of this material in the water cycle must be scientifically evaluated, particularly since large quantities of material will be involved. (Baker-FRC)
W82-03093

**1981 ANNUAL REPORT - COMMITTEE ON THE ASSESSMENT OF HUMAN HEALTH EFFECTS OF GREAT LAKES WATER QUALITY.**
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Water Quality Board.
For primary bibliographic entry see Field 5A.
W82-03104

**SUSCEPTIBILITY OF AQUATIC ECOSYSTEMS TO THE EFFECTS OF ATMOSPHERIC POLLUTANT FALLOUT IN QUEBEC.**
Scientific Series No 118, 1981. 46 p, Fig, Tab, Ref, 2 Append.

Descriptors: Aquatic ecosystems, Atmospheric pollutants, Alkalinity, Calcium, Susceptibility, Lake water, Chemistry, Analyses, Aquatic environment, *Air pollution effects, *Acid rain, *Lakes, *Ecological effects, *Quebec.

The Quebec Region of the Inland Waters Directorate has a special interest in the evaluation of the sensitivity of aquatic ecosystems to airborne pollutants. The impacts on the aquatic ecosystem have been summarized in a general way in terms of productivity and natural cycles as well as more specifically in terms of water quality, primary food chain (fungi, phytoplankton and macrophytes) and predators (zooplankton, macroinvertebrates, fish, amphibians). By critical review of the various methods used to determine the degree of acidification of surface waters, it is shown that in order to evaluate the sensitivity of Quebec waters one must take into account several integrating parameters such as the pH, calcium, the calcium saturation index, alkalinity, sulphates and minor ions. It is noted that prior to 1979 there is a lack of data for most of these parameters. Interpretative methods are chosen and applied to the available data prior to 1979 for a series of 194 lakes in the province of

Quebec. Also, it is shown that the sensitivity of Quebec lakes can only be determined by combining two different interpretative methods: (1) a method to differentiate between acidified and non-acidified lakes and (2) a method which allows one to evaluate the calcium saturation index of the lakes studied. (WATDOC)
W82-03106

**LAKE DEOXYGENATION AFTER HERBICIDE USE: A SIMULATION MODEL ANALYSIS,**
Notre Dame Univ., IN. Dept. of Biology.
S. R. Carpenter, and J. K. Greenlee.
Aquatic Botany, Vol 11, No 2, p 173-186, September, 1981. 6 Fig, 3 Tab, 25 Ref.

Descriptors: *Lakes, *Oxygen depletion, *Herbicides, Water pollution effects, *Model studies, Simulation analysis, Dissolved oxygen, Littoral zone, Macrophytes, Aquatic plants, Water temperature, Water circulation.

A model was developed to simulate the effects of herbicide treatment of macrophytes on the oxygen concentrations in the littoral zones of shallow unstratified lakes. Oxygen dynamics were governed by four processes: diffusion, advection, respiration, and photosynthesis. Several factors in deoxygenation were considered: average water temperature, turnover rate of littoral water, depth of the littoral zone, depth of the pelagic zone, biomass of macrophytes, macrophyte shoot nitrogen concentration, and the source of advective inputs to the littoral zone. None of these factors adequately predicted deoxygenation when considered alone. However, deoxygenation was less likely at low water temperatures, rapid littoral flushing rates, greater littoral depths, low levels of macrophyte biomass, and low tissue nitrogen concentrations. If weather conditions change toward calmer and warmer weather after herbicide application, there is a serious risk of deoxygenation even though conditions during application were optimal. (Cassar-FRC)
W82-03113

**EUTROPHICATION OF THE LAKE-RESERVOIR SIDI MOHAMED BEN ABDELLAH, RABAT, MOROCCO (L'EUTROPHISATION DU LAC-RESERVOIR SIDI MOHAMED BEN ABDELLAH PRES DE RABAT, MAROCO),**
Service Controle de Qualite des Eaux, Rabat (Morocco).
For primary bibliographic entry see Field 2H.
W82-03118

**A MODEL RIVER TEST TO DESCRIBE THE VARIOUS IMPACTS OF CHEMICAL SUBSTANCES ON MICROBIAL BIOCOMMUNITIES,**
Karlsruhe Univ. (Germany, F.R.). Inst. of Bioengineering and Biotechnology of Wastewater.
P. Wilderer.
AIChE Symposium Series, Vol 77, No 209, p 205-213, 1981. 15 Fig, 9 Ref.

Descriptors: *Water pollution effects, *Model studies, Rivers, Biodegradation, Toxicity, Organic compounds, Microorganisms, *Microbiological studies, Biochemistry, Chemical reactions, *Ecological effects.

A test method is described which was used to study the effects of chemical substances on aquatic microbial systems. The test method contains both continuous flow experiments to simulate the chain of ecological elements in biological wastewater treatment and self purification systems and batch experiments to quantify the impacts of particular substances on specific biocommunities in the various ecological elements. The test is based on a series of ecological systems developed in a laboratory model river consisting of a number of small aerated reactor vessels connected in series to form a reactor cascade. Subsequently the wastewater constituents and the metabolities produced are degraded by a series of biocommunities established throughout the course of the cascade. The study concluded that criteria such as biodegradability, persistence or toxicity are not primarily properties of any chemical substance, but properties of ecological systems. Of the four test substances used, diethyleneglycol, 4-nitrophenol, 2-methyl-2-,4-pentaneodiol, and thioglycolic acid, all were persistent before adaptation and two were toxic. After an adaptation period, all were biodegradable and less toxic. To eliminate these four substances, two mutually exclusive operating conditions are needed. A high F/M ratio is needed to remove 4-nitrophenol and thioglycolic acid, whereas low loading conditions must be maintained to eliminate the other two. (Baker-FRC)
W82-03147

**PARAMETRIC MODEL AND OPTIMAL PREDICTION OF THE AVERAGE SALINITY OF THE AZOV SEA,**
Academiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
For primary bibliographic entry see Field 5G.
W82-03154

**SALINITY AND BIOGENIC MATERIAL IN THE NORTH CASPIAN,**
Kaspiiskii Nauchno-Issledovatelskii Inst. Rybnogo Khozyaistva, Astrakhan (USSR).
For primary bibliographic entry see Field 4A.
W82-03155

**PHOSPHORUS AND NITROGEN BUDGETS OF BARTON BROAD AND PREDICTED EFFECTS OF A REDUCTION IN NUTRIENT LOADING ON PHYTOPLANKTON BIOMASS IN BARTON, SUTTON AND STALHAM BROADS, NORFOLK, UNITED KINGDOM,**
University of East Anglia, Norwich (England). School of Environmental Sciences.
P. L. Osborne.
Internationale Revue der Gesamten Hydrobiologie, Vol 66, No 2, p 171-202, 1981. 16 Fig, 5 Tab, 49 Ref.

Descriptors: *Lakes, *Eutrophication, Phytoplankton, Phosphorus, Nitrogen, *Nutrients, Biomass, Macrophytes, Wastewater, Drainage water, Water pollution effects, Barton Broad, *England.

Seasonal variations in phytoplankton standing crops and the sources, seasonal cycles and supply of phosphorus and nitrogen were studied in three shallow, eutrophic lakes and their inter-connecting river. The Norfolk Broads are a series of shallow lakes associated with five main rivers. The lakes were formed during flooding of peat excavations. They are shallow freshwater lakes in which nutrient enrichment has resulted in replacement of a diverse macrophyte flora with large populations of phytoplankton. Phytoplankton pigment concentrations were relatively low at all stations during the winter, but concentrations increased at all stations in spring in response to increased temperatures and light intensities and a reduced flushing rate. Chlorophyll a concentrations were very high in summer: a maximum of 584 mg/cubic meter was recorded in Barton Broad. Nitrogen loadings on Barton Broad were estimated at 186-202 g N/sq m/year, of which 116 g was attributed to land drainage and the balance to sewage effluent sources. Total phosphorus loading was 18-22 g/sq m/year; over 80% of this was derived from sewage sources. About half of the P entering the River Ant-Broads system is stored in sediments, while 7-10 g/sq m/year enters Barton Broad dissolved and suspended in the water. It is suggested that an 80% reduction in the phosphorus content of sewage effluents entering the River Ant above Barton Broad would allow restoration of submerged macrophytes. (Baker-FRC)
W82-03184

**RELATIONSHIP BETWEEN CHLOROPHYLL-A CONCENTRATION AND PHYTOPLANKTON BIOMASS IN SEVERAL RESERVOIRS IN CZECHOSLOVAKIA,**
Ceskoslovenska Akademie Ved, Prague. Hydrobiologicka Lab.
For primary bibliographic entry see Field 2H.
W82-03185

**EUTROPHICATION, ACCELERATED BY POLLUTION,**
Societe Lyonnaise des Eaux et de l ' Eclairage (France). Lab.
M. M. Rizet.
Aqua, Vol 5, p 9-10, 13-15, 1981. 5 Fig, 2 Tab, 26 Ref.

Descriptors: *Eutrophication, *Water pollution control, Water pollution sources, Water pollution treatment, Nitrogen, Phosphorus, Drinking water, Potable water, Organic compounds.

Consideration is given to the problems of a eutrophic and dystrophic aqueous environment that is too highly nourished by exogenous intake. Oligotrophy can be considered to be the initial state of an aquatic biotope in a zone poor in nutrients. Such a biotope is itself inescapably liable to eutrophication. The essential point is the kinetics of this process, which is extremely variable. The process can be noticeably accelerated by natural or artificial happenings. Human activity, urbanization, industry, and intensive agriculture can significantly accelerate the eutrophication of receiving water. The specific impact of mineral elements brought to the water area can be direct, by metabolism of the dissolved elements. Considerable density of biomass complicates the preparation of drinking water. Taste and smell are the result of the presence of living algae or the products of their decomposition. Toxicity of metabolities emitted by certain algae has been the cause of acute mammalian intoxications. The fight against eutrophication must be waged where pollution sources enter the environment. The non-point input arising from agriculture can be reduced by more rational use of fertilizer products. The chemical industry is proposing substitutes for phosphate detergents. Nitrogen and phosphorus carried by domestic or industrial wastewater can be eliminated from water by physico-chemical or biological precipitation, by bioconsumption in lagoons, or by decomposition of nitrogen to the gaseous state. The limitation of excessive richness in nutritive elements and especially the limitation of algae development can be obtained by causing effective mixing of influent water. (Baker-FRC)
W82-03193

**THE STRUCTURE OF BENTHIC COMMUNITIES IN AN AREA OF THERMAL DISCHARGE FROM A COASTAL POWER STATION,**
Modena Univ. (Italy). Inst. of Zoology.
R. Crema, and A. M. B. Pagliai.
Marine Pollution Bulletin, Vol 11, No 8, p 221-224, August, 1980. 5 Fig, 2 Tab, 13 Ref.

Descriptors: *Benthic fauna, *Thermal pollution, *Coastal waters, *Powerplants, Polychaetes, Population density, Aquatic populations, Mollusks, Crustaceans, Echinoderms, *Italy, Gulf of Follonica, Piombino.

The increasing use of seawater for cooling powerplants has raised many questions regarding the effects of heated effluents discharged from these facilities on the marine environment. The Piombino power station, located at Torre del Sale in the center of the Gulf of Follonica in Italy, currently consists of two sections, each producing 320 megawatts and using 22 cubic meters of seawater per second for cooling. With a temperature gradient of 9 degrees C across the plant, about 190 megacalorie of heat per second is discharged into the sea. A sampling plan was devised to allow comparison of the benthic communities of zones in proximity to the effluent outlet with those of zones unaffected by heated effluent. Polychaetes were the predominant taxa at all of the sampling sites, followed by mollusks and crustaceans. Typical infralittoral forms of polychaetes were found at the different depths. The numerical distribution of individuals per species was found to be log-normal in all samples. Previous studies have demonstrated that the log-normal model describes the distribution of a community in equilibrium and that the distribution deviates from the log-normal when the community is evolving towards a new equilibrium in response to pollution. The sampling method was found to be sensitive to the differences in commu-

nities related to depth, but showed no differences connected with proximity to the heated effluent. Comparison of these data with data collected at subsequent stages in the development of the full plant capacity is expected to provide some information on the amounts of heat the environment can receive without damage. (Carroll-FRC)
W82-03205

**EFFECTS OF EUTROPHICATION ON THE INTERTIDAL ECOLOGY OF LANGSTONE HARBOUR, U.K. AND PROPOSED CONTROL MEASURES,**
Southern Water Authority, Worthing (England).
H. A. C. Montgomery, and P. G. Soulsby.
Water Science and Technology, Vol 13, No 7, p 287-294, 1981. 2 Fig, 3 Tab, 10 Ref.

Descriptors: *Wastewater pollution, *Water pollution effects, *Eutrophication, *Nutrients, *Harbors, Wastewater disposal, Wastewater discharge, Algal growth, Algal control, Benthic fauna, Biomass, Biological wastewater treatment, Nutrient removal, Nitrogen, Phosphorus, Phosphates, *Langstone Harbor, England.

Eutrophic conditions have developed in Langstone Harbor, a natural saline tidal basin off the South Coast of England. The disposal of about 40 megaliters/day of biologically treated sewage effluent into the north end of the harbor and an input of crude sewage on the ebb tide at the south end of the harbor have caused an overgrowth of the alga, Enteromorpha spp. on the intertidal mudflats. Manual and aerial photographs of the area were taken to estimate the coverage by the macroalgae from 1973 to 1979. Measurements of the algal biomass and benthic fauna were also taken. Algal biomass was significantly reduced in 1979 compared to 1978 data. The biomass of benthic from areas of high weed cover was significantly higher than that from areas with no weed cover. Seasonal studies of nutrient levels in harbor water are needed to clarify nitrate, nitrogen phosphate, and ammonia-nitrogen data. Preliminary samplings showed a clear pattern of dilution of these nutrients from the head to the mouth of the harbor. Plans to prevent further eutrophication include the adoption of nutrient removal measures at the sewage treatment works at the Budds Farm facility at the north end of the harbor. (Geiger-FRC)
W82-03207

**EUTROPHICATION OF THE SALT VALLEY RESERVOIRS, 1968-1973. II. CHANGES IN PHYSICAL AND CHEMICAL PARAMETERS OF EUTROPHICATION,**
Nebraska Univ.-Lincoln. School of Life Sciences.
G. L. Hergenrader.
Hydrobiologia, Vol 74, No 3, p 225-240, September 21, 1980. 16 Fig, 2 Tab, 31 Ref.

Descriptors: *Reservoirs, *Eutrophication, Water pollution effects, *Salt Valley, *Nebraska, Phytoplankton, Nutrients, Nitrogen compounds, Phosphates, Sulfates, Chlorides, Turbidity, Suspended solids, Alkalinity, Hardness, Calcium, Dissolved solids, Iron.

Eutrophication indicators were studied in four new, small, shallow, holomictic, eutrophic flood control reservoirs in Nebraska's Salt Valley. Weekly samples were taken during the summers of 1968-1973. Secchi disk transparencies decreased with time from 200 cm to 100 cm and were lowest in the oldest reservoir. (One reservoir with unusually high inorganic turbidity was not considered in this aspect.) As the reservoirs became more eutrophic over the study period, mean turbidity and mean suspended solids increased. Total alkalinity, total hardness, calcium, and phosphates (total unfiltered, total filtrate, and orthophosphate) all decreased during the 6 year period. These decreases were caused by intensive phytoplankton photosynthesis, which promoted more formation. Phosphorus coprecipitated with the marl. Parameters which were unreliable as eutrophication indicators were temperature, dissolved oxygen, dissolved solids, nitrate and ammonia nitrogen, and total iron. Although chloride and sulfate increased with progressive eutrophication, they were not considered reliable indicators. Chloride cannot be related to human activities. Sulfate data needs a longer observation period to determine the correlations. (Cassar-FRC)
W82-03214

**THE COMPOSITION AND ECOLOGY OF PERIPHYTON COMMUNITIES IN FRESHWATERS. II. INTER-RELATIONSHIPS BETWEEN WATER CHEMISTRY, PHYTOPLANKTON POPULATIONS AND PERIPHYTON POPULATIONS IN A SHALLOW LAKE AND ASSOCIATED EXPERIMENTAL RESERVOIRS ('LUND TUBES'),**
University of East Anglia Univ., Norwich (England). School of Environmental Sciences.
For primary bibliographic entry see Field 2H.
W82-03217

**BIOLOGICAL MONITORING PART VI - FUTURE NEEDS,**
Virginia Inst. and State Univ., Blacksburg. Dept. of Biology.
J. Cairns Jr.
Water Research, Vol 15, No 8, p 941-952, August, 1981. 1 Fig, 55 Ref.

Descriptors: *Monitoring, *Chemical properties, *Toxicity, *Environmental effects, Risks, Ecosystems, Research priorities, Water pollution effects, *Biological samples.

System level tests rather than single species toxicity tests are urged as a more satisfactory way to determine the environmental effects of contaminants. The suggestion that at least multispecies tests should be required in biological monitoring studies is scientifically sound, but may be economically impractical. However, this type of test should be done for all chemicals that find their way into the environment. The appropriate mix of evidence required can be determined on a case-by-case basis using protocols developed for this purpose. When the cost of proceeding without an adequate risk assessment exceeds the cost of getting the necessary information through system tests and advanced monitoring, the cost of getting a more reliable estimate of risk seems more reasonable. New monitoring methods, particularly those geared to system and multispecies tests, are needed to perform monitoring methods on the scale that is necessary today. Numerous applications of these concepts in the field of water research are cited. Significant toxicity of polychlorinated biphenyls was determined in multispecies tests on aquatic invertebrates as contrasted to single species tests. Benefits of improved wastewater treatment systems and reduced industrial discharges have been demonstrated in the Wabash, Shenandoah, and South Rivers in the United States and the Thames and Clyde Rivers in England, among others. The importance of drainage basin management and determination of ecosystem assimilative capacity are illustrated. (Small-FRC)
W82-03230

**IMPACT OF NUTRIENT ENRICHMENT IN A WATERCHESTNUT ECOSYSTEM AT TAKAHAMA-IRI BAY OF LAKE KASUMIGAURA, JAPAN. V. DYNAMICS OF ORGANIC DEBRIS,**
Meikei High School, Ibaraki (Japan).
For primary bibliographic entry see Field 2H.
W82-03231

**PERSISTENT BLOOMS OF SURF DIATOMS ALONG THE PACIFIC COAST, U.S.A. I. PHYSICAL CHARACTERISTICS OF THE COASTAL REGION IN RELATION TO THE DISTRIBUTION AND ABUNDANCE OF THE SPECIES,**
Washington Univ., Seattle. Dept. of Oceanography.
J. L. Garver, and J. Lewin.
Estuarine, Coastal and Shelf Science, Vol 12, p 217-229, 1981. 7 Fig, 2 Tab, 21 Ref.

Descriptors: *Algae, *Eutrophication *Population dynamics, *Coastal waters, Diatoms, Beaches, Chlorite, Montmorillonite, Seasonal variation, Physical properties, Pacific Ocean, Washington, Oregon.

A study was undertaken to establish the ranges of the two surf diatoms along the Pacific coast and to characterize the types of beaches and coastline associated with algal blooms. Water samples were taken every three weeks at Copalis Beach on the southern Washington coast and monthly at 12 beaches on the Oregon coastline. Only samples collected during daylight hours were included in the study. Chaetoceros armatum was present in surf samples at Copalis Beach and at all beaches on the Oregon coast with the exception of two at the southern end. A seasonal trend was not evident, but higher cell nubers were seen from October to January and during April and May. Asterionella socialis was present over the same geographical range as C. armatum. The abundance of A. socialis followed a more seasonal trend, with low numbers from June to September 1977, higher densities from October through May, and lower numbers again during the succeeding summer months. The northern beaches had high cell counts of both species, often exceeding 10,000 cells/ml. Five beaches per ml most of the time, but these blooms were not as persistent as those found along the northern group of beaches. Depressed numbers of both species remaining around 100 cells/ml were found at the next two beaches moving southward, and at the two southernmost beaches sampled the two surf species were absent. Discriminant analysis showed that the four groups could be completely separated by three discriminant functions composed of four physical variables: offshore bottom slope, percent chlorite, percent montmorillonite and beach length. (Baker-FRC)
W82-03233

**STUDY ON THE SCARCITY OF RED TIDE IN THE EUTROPHICATED WATERS OF ARIAKE BAY I. DISSOLUTION OF PHOSPHATE ION FROM BOTTOM MUD BY HYDROGEN SULFIDE,**
Kyushu Univ., Fukuoka (Japan). Lab. of Fisheries and Chemistry.
S. Ishio, and K. Kondo.
Bulletin of the Japanese Society of Scientific Fisheries, Vol 46, No 8, p 977-989, August, 1980. 2 Fig, 9 Tab, 14 Ref.

Descriptors: *Eutrophication, *Red tide, *Nutrients, Water pollution effects, Fate of pollutants, Ariake Bay, Hakata Bay, *Japan, Dinoflagellates, Bottom sediments, Marine sediments, Bays, Phytoplankton, Phosphates, Nitrogen, Sulfides, Hydrogen sulfide, Benthos, Iron compounds, Tidal effects, Oxidation.

Although Araike Bay and Hakata Bay, Japan, are similarly eutrophied, red tide is a serious problem only in Hakata. Examination of the bottom muds of both bays showed similar levels of total C, total N, and total P, but differences in phosphate-P removal by 1% NaS solution were remarkable--236 plus or minus 227 mg per kg dry mud in Ariake and 80 plus or minus 50 mg per kg in Hakata. Average content of slufide-S in Hakata (0.654 g per kg dry mud) was 3.5 times that in Ariake (0.185 g per kg dry mud). The difference in sulfide concentrations is caused by a rapid tidal current and oxidizing conditions present in Ariake, but not in Hakata. In Hakata, soluble sulfides react with the available ferric phosphate to precipitate FeS and rapidly release phosphates into water, where this nutrient supports late summer dinoflagellate blooms. In Ariake, the FeP04 remains in the mud and is released more gradually. (Cassar-FRC)
W82-03240

**EFFECTS OF POLLUTION ON HUMIC SUBSTANCES,**
Department of Agriculture, Ottawa (Ontario). Chemistry and Biology Research Inst.
M. Schnitzer, and H. Kerndorff.
Journal of Environmental Science and Health, Part B, Vol 15, No 4, p 431-456, 1980. 6 Fig, 8 Tab, 12 Ref.

Descriptors: *Decomposing organic matter, *Water pollution effects, *Humic acids, Fulvic acids, Acidity, Chemical properties, Nitrogen, Sulfur, Sediments, Metals.

Humic acids and fulvic acids were isolated from unpolluted and polluted soils and sediments in an effort to assess the effects of industrial and environmental pollution on analytical characteristics of humic substances. The humic acids and fulvic acids were characterized by elemental and functional group analyses, by infrared spectrophotometry, by differential thermal analysis, and by analyses for 13 metals. Silicon was also determined in all samples. Soil and sediment samples were taken from six heavily polluted environments and from six pristine, isolated locations where little pollution was expected to occur. The polluted humic acids and fulvic acids contained more nitrogen and sulfur than unpolluted samples, while unpolluted samples contained more oxygen than polluted ones. Polluted samples were also richer than unpolluted samples in all of the 13 metals and in silicon. Increases in COO(-) groups, secondary non-cyclic amides, and possibly S03H groups were found in the polluted humic acids and fulvic acids. Differential thermal analyses showed that polluted humic materials were more thermostable than unpolluted humic acids and fulvic acids. The study results indicate that unusually high concentrations of nitrogen, sulfur, copper, chromium, zinc, and mercury in humic materials may be useful indicators of soil and sediment pollution. (Carroll-FRC)
W82-03253

**METHYLMERCURY CONTAMINATION OF AN EXPERIMENTAL TROPHIC CHAIN: IMPORTANCE OF THE PRIMARY PRODUCER-CONSUMER SYSTEM. (CONTAMINATION D'UNE CHAINE TROPHIQUE EXPERIMENTALE PAR LE METHYLMERCURE: IMPORTANCE DU SYSTEME 'PRODUCTEUR-CONSOMMATEUR PRIMAIRE'),**
Bordeaux-1 Univ., Talence (France). Lab. d'Ecologie et Ecophysiologie Animales.
F. Robeyre, A. Boudou, and A. Delarche.
Environmental Pollution, Vol 24, No 3, p 193-206, March, 1981. 3 Fig, 3 Tab, 22 Ref.

Descriptors: *Mercury, *Bioaccumulation, *Algae, Toxicology, Food chains, Heavy metals, *Ecosystems, Water pollution.

Within the framework of methylmercury bioaccumulation and bioamplification along an experimental food chain with four links, the contamination procedure of the first two trophic levels, Chlorella vulgaris and Daphnia magna, is accurately defined. After developing the chosen methodology and the constraints inherent in each link, the main results showing the primary producer are presented from the toxicological point of view (inhibition rate of Chlorella growth). A sublethal concentration is defined for each species in the model and the dynamics of mercury fixation for Chlorella vulgaris and Daphnia magna are quantified at three temperatures over contamination periods of 24 hours and 96 hours, respectively. The study demonstrates the great fixation capacity of algae for mercury. Therefore, the first consumer level is essentially contaminated trophically. The study results underline the temperature factor effect on Daphnia magna accumulation processes; moulting, in relation to temperature, partly explaining the differences observed. The high values of the pollutant concentration factors relative to the water-Chlorella-Daphnia system confirm the importance of the inclusion of an autotrophic link at the base of an experimental trophic chain. On the other hand, the accuracy of the measurement shows the high level of reliability and reproducibility of the procedure chosen. (Carroll-FRC)
W82-03303

**SESSILE ALGAE IN EUROPEAN MOUNTAIN STREAMS. I. THE ECOLOGICAL CHARACTERISTICS OF COMMUNITIES,**
Polish Academy of Sciences, Krakow. Zaklad Biologii Wod.
B. Kawecka.
Acta Hydrobiologica, Vol 22, No 4, p 361-420, 1980. 16 Fig, 4 Tab, 79 Ref.

Descriptors: *Algae, *Stream degradation, *Mountains, Wastewater pollution, Reviews, Water pollution effects, Tourism, Wastewater disposal, Diatoms, Stream biota, Mountain streams, Europe.

The structure and ecology of sessile algae communities were investigated, and the changes in these characteristics caused by water pollution were determined. The investigation was carried out in pure high mountain streams which were polluted by sewage from tourist centers at various locations: Kebnekaise Mountains, Swedish Lapland; Tatra Mountains, Poland; Alps, Austria; Fagaras Mountains, Rumania; and Rila Mountains, Bulgaria. Seven algae communities were identified as being characteristic of unpolluted streams and three communities were found characteristic of streams polluted chiefly by domestic sewage. Algae developing in glacier streams had poor development of diatoms, while outflows from mountain lakes had abundant development of Cyanophyceae and lichens. A glacier stream below the inflow of domestic sewage in winter had a marked increase in diatoms. This may be due to increases in nitrate content. Domestic wastes influenced algae communities, whose structure was considerably changed as compared to communities of pure environments. (Small-FRC)
W82-03309

**LEMNA (DUCKWEED) AS AN INDICATOR OF WATER POLLUTION. I. THE SENSITIVITY OF LEMNA PAUCICOSTATA TO HEAVY METALS,**
Shinshu Univ., Matsumoto (Japan). Dept. of Public Health.
For primary bibliographic entry see Field 5A.
W82-03318

**ECOLOGICAL EFFECTS OF MINE EFFLUENTS ON THE SOUTH ESK RIVER, NORTH-EASTERN TASMANIA. I. STUDY AREA AND BASIC WATER CHARACTERISTICS,**
National Museum of Victoria, Melbourne (Australia).
R. H. Norris, P. S. Lake, and R. Swain.
Australian Journal of Marine and Freshwater Research, Vol 31, No 6, p 817-827, December, 1980. 8 Fig, 5 Tab, 30 Ref.

Descriptors: *Industrial wastes, *Rivers, *Tasmania, South Esk River, Mine wastes, Effluents, Acidity, Acid mine drainage, Cations, Phosphates, Chlorides, Nitrates, Seasonal variation, Rainfall, Temperature effects.

A study was made of the effects of mine effluents on the environment of the South Esk River in northeastern Tasmania. The study was conducted along 180 km of the river, over which distance it falls 20 meters, terminating at the Tamar estuary. The total catchment area is 8972 square kilometers, of which 7142 wquare kilometers is over the main sampling area. Land uses on the catchment include forestry, hydroelectric power generation and mixed farming. Effluents arise from mining operations in the area, which produce tin and tungsten. The dissolved oxygen concentrations of the river were at, or near, saturation levels. pH was slightly acid and was constant along the river course at any one time, indicating a reasonably well-buffered natural water. pH correlated positively with alkalinity and calcium, magnesium and sodium concentrations, all reaching their highest levels in the summer of 1975-76 after heavy rainfall during 1975. Dissolved carbon dioxide concentrations were generally above saturation levels. The major cation concentrations increased down-river. Low levels of phosphate, chloride, and nitrate indicate that the South Esk River is free of organic contamination by domestic and agricultural effluents. (Baker-FRC)
W82-03322

**BACTERIAL UTILIZATION OF ALGAL EXTRACELLULAR PRODUCTS. I. THE KINETIC APPROACH,**
Middlebury Coll., VT. Dept. of Biology.
W. H. Bell.
Limnology and Oceanography, Vol 25, No 6, p 1007-1020, November, 1980. 5 Fig, 1 Tab, 34 Ref.

Descriptors: *Algae, *Heterotrophic bacteria, *Kinetics, *Model studies, Bacteria, Experimental data, Eutrophication, Organic compounds, Water pollution effects, Skeletonema costatum, Chaetoceros affinis.

Equations for linear kinetic analysis of the utilization of algal extracellular products by bacteria were developed from a model for estimating heterotrophic potential originally proposed by Parsons and Strickland (1961) and subsequently modified. Laboratory studies using marine diatoms Skeletonema costatum and Chaetoceros affinis and a marine bacteria agreed with theoretical predictions below a substrate concentration of 400 micrograms C per liter. Thus changes in heterotrophic population size and concentration of extracellular products can be predicted. Deviations from linear predictions of the model may show the specificity of algal-bacterial interactions mediated by extracellular products. Application of the mixed substrate model may allow qualitative evaluation of the ecological significance of a phycosphere effect produced by algal blooms. (Cassar-FRC)
W82-03330

**BACTERIAL UTILIZATION OF ALGAL EXTRACELLULAR PRODUCTS. 2. A KINETIC STUDY OF NATURAL POPULATIONS,**
Middlebury Coll., VT. Dept. of Biology.
W. H. Bell, and E. Sakshaug.
Limnology and Oceanography, Vol 25, No 6, p 1021-1033, November, 1980. 6 Fig, 1 Tab, 36 Ref.

Descriptors: *Algae, *Heterotrophic bacteria, *Kinetics, Eutrophication, Model studies, *Bacteria, Organic compounds, Water pollution effects, Skeletonema costatum, Chaetoceros affinis, *Norway.

The model for bacterial utilization of algal extracellular products was applied to a study of the uptake of C14-labeled extracellular products from Skeletonema costatum by native populations during an algal bloom in Trondheimsfjord, Norway, in 1977. Data obtained on 10 separate dates showed agreement with the linear predictions of the mixed substrate model. A 4-fold increase in bacterial activity was enough to prevent a large accumulation of extracellular products. During the later exponential phase of the bloom temporary inhibition of bacterial activity occurred. Chaetoceros affinis, a native alga not represented in the bloom, was used to evaluate the specificity of the algal-bacterial system. Results indicated that the bacterial population was not adapted to use C. affinis extracellular products during this bloom but was stimulated by the bloom to specifically use S. costatum extracellular products. (Cassar-FRC)
W82-03331

**DETOXIFICATION OF ZINC AND CADMIUM BY THE FRESHWATER PROTOZOAN TETRAHYMENA PYRIFORMIS. II. GROWTH EXPERIMENTS AND ULTRASTRUCTURAL STUDIES ON SEQUESTRATION OF HEAVY METALS,**
Queen Elizabeth Coll., London (England). Dept. of Biology.
For primary bibliographic entry see Field 5G.
W82-03334

**PHYSICAL VARIABILITY AND PHYTOPLANKTON COMMUNITIES: II. PRIMARY PRODUCTIVITY BY PHYTOPLANKTON IN A PHYSICALLY VARIABLE ENVIRONMENT,**
McMaster Univ., Hamilton (Ontario). Dept. of Biology.
G. P. Harris, G. D. Haffner, and B. B. Piccinin.
Archiv fur Hydrobiologie, Vol 88, No 4, p 393-425, June, 1980. 11 Fig, 3 Tab, 113 Ref.

Descriptors: *Phytoplankton, *Photosynthesis, *Temperature, Water pollution effects, Eutrophication, Aquatic life, *Lake Ontario.

This paper describes the week-by-week changes in the primary productivity of phytoplankton communities in Hamilton Harbor during the ice-free periods of 1975, 1976, and 1977. Measurements were made by the carbon-14 technique. Integral photosynthesis was lower than had been expected in a highly eutrophic water body. A significant

portion of the variability associated with the integral photosynthesis can be accounted for by the changes in the photosynthetic capacity of the phytoplankton. The variability in the photosynthetic saturation parameter correlated with thermal stability in the top 5 m of the water column. Significant self-shading by the phytoplankton was only recorded in 1975 and 1977. Physical changes in 1976 appeared to preclude any self-shading in that year. In this physically variable situation, the phytoplankton communities exhibited reduced photosynthetic capacity and reduced growth rates. Thus the total algal biomass in Hamilton Harbor did not reach levels predicted by phosphorus loading models. The usefulness of such data for management strategies is briefly discussed. (Baker-FRC)
W82-03336

**CHEMICAL FLUX IN AN ACID-STRESSED STREAM,**
Cornell Univ., Ithaca, NY. Section of Ecology and Systematics.
R. J. Hali, and G. E. Likens.
Nature, Vol 292, No 5821, p 329-331, July 23, 1981. 1 Fig, 1 Tab, 35 Ref.

Descriptors: *Acidic water, *Streams, *Ecological effects, Water pollution effects, Snowmelt, *Acid rain, Nutrients, Invertebrates, Aluminum, Organic matter, Aquatic life, Hydrogen ion concentration, Norris Brook, Hubbard Brook, *New Hampshire, Sulfuric acid.

The pH of a third-order stream, Norris Brook, New Hampshire, which normally is slightly acidic (pH 5.4-6.4) was maintained at pH 3.9-4.2 with sulfuric acid additions from April 18 to September 22, 1977. Effects were divided into acute (5-day, simulating spring snowmelt) and chronic (25-day, simulating chronic effects of acid rain). Invertebrates decreased 285% during the first five days and 58% at 25 days. This may have been a result of a decrease in collector organisms. Aluminum decreased 160% in five days and 86% after 25 days. Coarse particulate matter (leaves, tiny branches, etc.) decreased by 107% after five days but increased 18% after 25 days. Little or no change was seen in fine particulate organic matter, dissolved organic carbon, Ca, or N. Significant amounts of C, N, and P were lost from the ecosystem in the biologically bound form and in the particulate organic fraction. This has a detrimental effect on the acidified area and can be either beneficial or detrimental further downstream. (Cassar-FRC)
W82-03338

**ACID PRECIPITATION--A NEW STUDY FROM NORWAY,**
Imperial Coll. of Science and Technology, London (England). Centre for Environmental Technology.
J. N. B. Bell.
Nature (London), Vol 292, No 5820, p 199-200, July 16, 1981.

Descriptors: *Acid rain, *Norway, *Precipitation, *Ecological effects, Environmental effects, Aquatic life, Water pollution effects, Air pollution effects, Water pollution sources, *Lakes.

An accelerating decline in fish stocks which resulted in the extinction of fish populations in an area of 13,000 square kilometers and severe problems over another 20,000 square kilometers led to the establishment in 1972 of a major Norwegian research program (the SNSF project) into the biological effects of acid precipitation. The final report of this project, published in 1980, demonstrates that precipition in southern Scandinavia has become more acidic as a result of long-distance transport of air pollution. Nitrogen oxides are contributing an increasing proportion of the acidity. While routine analysis of precipitation samples provides estimates of the inputs of hydrogen ions, sulfur oxides, and nitrogen oxides, the importance of the dry deposition of gaseous and particulate sulfur and nitrogen compounds directly onto vegetation and soils is less well defined. Lake waters have become significantly more acidic in areas subject to acid precipitation. Acid precipitation also mobilizes aluminum in soils, which is a major factor in the destruction of fish populations. In southern Norway, where much of the precipitation falls as snow, particularly severe problems result from the flush of acid water into lakes during snow melt. Intensive studies failed to reveal any consistent effects of acid precipitation on forest productivity. Also, the effects of changes in land use on lake acidification are not fully understood. The SNSF project predicted that a reduction of at least 70 percent in hydrogen ions and sulfate concentrations in precipitation is necessary to restore lakes to their previous conditions. (Carroll-FRC)
W82-03341

## 5D. Waste Treatment Processes

**ASSESSMENT OF EMERGING TECHNOLOGIES FOR METAL FINISHING POLLUTION CONTROL: THREE CASE STUDIES,**
Centex Corp., Reston, VA.
P. Militello.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-244485, Price codes: A04 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-153, October, 1981. 4 p, 3 Fig, 3 Tab.

Descriptors: *Metal-finishing wastes, *Wastewater treatment, *Ozone, *Ion exchange, *Waste recovery, Industrial wastewater, Chromium, Cyanide, Metals, Suspended solids, Sludge drying.

Many novel approaches to treatment of electroplating wastewater have been evaluated based on available information under an earlier effort. The most promising of these were selected for further investigation to include sampling, performance verification, and cost analysis. The treatment methods studied included a system for treatment of electroplating wastes with ozone, a technique for chrome recovery by ion transfer, and a method of treating mixed wastestreams using ion exchange. The Ozodyne System at San Diego Plating exhibited reliable performance when operated on mixed wastewaters, reducing effluent concentrations of cyanide, metals, and total suspended soils to very low levels, often less than the limits of detectability. The vacuum filter employed as part of the system was able to dewater the resulting sludge to 75% solids content. The system should become highly competitive on a cost basis with conventional treatment as sludge disposal costs escalate. The ChromeNapper chrome recovery system at U.S. Plating exhibited reliable performance on a continuous unattended basis over several days of monitoring, successfully recovering and returning to the plating tank all chrome other than that plated on the workpiece. Economic comparison with conventional evaporative recovery shows the system to be highly attractive. Although the Rinse-Loop System at Chicago Modern Plating was plagued with operational difficulties from ancillary equipment, the basic ion exchange technology operated satisfactorily on the mixed wastewaters during those limited periods when it was possible to pay sufficient attention to maintenance. (Moore-SRC)
W82-03001

**TREATMENT OF METAL FINISHING WASTES BY USE OF FERROUS SULFIDE,**
Permutit Co., Inc., Monmouth Junction, NJ.
M. B. Yeligar, G. Bagenski, and R. M. Schlauch.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-233579, Price codes: A05 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-142, September, 1981. 4 p, 1 Fig, 1 Tab.

Descriptors: *Metal-finishing wastes, *Wastewater treatment, *Sulfide precipitation, Suspended solids, Cost analysis, Metals, Industrial wastes, Heavy metals, Chromium, Zinc, Process control.

The demonstration of a new patented sulfide precipitation process ('Sulfex') which removes heavy metals from metal finishing wastewaters, was performed to verify its operational practicability and performance quality. The study was performed at a carburetor manufacturing plant in Paris, Tennessee. 'Udylite' processes are used for chromate conversion coatings on aluminum and zinc carburetor castings before assembly. The sulfide precipitation system removes chromium and zinc from the plant's combined metal finishing process wastewater. It also removes suspended material such as precipitated aluminum, iron, and phosphates. Major steps in the system are: equalization and neutralization of untreated wastewater, precipitation of metals and sedimentation of suspended solids, polishing of settler effluent with dual media filtration, and final dewatering of settled sludge. All metals and suspended solids were removed to levels well below both the City of Paris sewer system limitations and the Tennessee guidelines for indirect discharge to sewer systems. Jar tests were demonstrated to be a valuable tool for maintaining good process control and economical operation. The chemical cost of sulfide precipitation has been found to be directly dependent upon the concentrations of combined zinc and hexavalant chromium present during the process. Sulfide precipitation was shown to be an economical as well as effective treatment for this type of wastewater. (Moore-SRC)
W82-03002

**SOIL FILTRATION OF SEWAGE EFFLUENT OF A RURAL AREA,**
Colorado State Univ., Fort Collins. Dept. of Agronomy.
B. R. Sabey, K. A. Barbarick, and N. A. Evans.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-238073, Price codes: A06 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-151, September, 1981. 4 p, 1 Fig, 1 Tab, 2 Ref.

Descriptors: *Wastewater irrigation, *Snow cover, *Weather, *Sprinkler irrigation, Soil filters, Municipal wastewater, Tile drainage, Groundwater pollution, Water quality, Wastewater treatment, Soil properties.

The effects of sprinkler-irrigated municipal sewage effluent and of surface tile drainage on a mountain meadow were investigated in the summer of 1977 and 1978. The treatments consisted of combinations of irrigations with effluent or ditch water at the rate of 7.5 cm/week and of drainage tiles or natural drainage. The drainage tiles were effective in lowering the groundwater elevations for about 85% and 10% of the season in 1977 and 1978, respectively. Higher plant concentrations of sodium and manganese in 1977 and plant yields and Mn concentration in 1978 were found in the plants harvested from the plots that were irrigated with sewage effluent. The influence of the effluent on groundwater quality and soil characteristics did not pose serious health or environmental problems. Another study to determine the feasibility of adding sewage effluent to mountain meadow land during winter was inititated in 1977 at Hayden, Colorado, near the summer effluent application site. It was determined that 7.5 cm/week of effluent could be added to the plots under an ice or snow cover if the soil profile was not frozen prior to ice and snow cover formation in the late fall and early winter. The size of ridge and furrow configuration did not influence any of the biological and chemical parameters measured in the study. The winter soil filtration system was effective in decreasing the concentrations of some chemical constituents including ammonium and potassium, as well as decreasing biochemical oxygen demand, chemical oxygen demand, and indicator organisms. The decrease in indicator organism numbers was not as great the second year of the study as it was the first. In general, the effluent distribution system worked reasonably well even in the winter as long as rapid drainage of the pipes was provided at the conclusion of the application period of each day. (Moore-SRC)
W82-03004

**VIRUS INACTIVATION IN WASTEWATER EFFLUENTS BY CHLORINE, OZONE, AND ULTRAVIOLET LIGHT,**
Radian Corp., Austin, TX.
R. A. Fluegge, T. G. Metcalf, and C. Wallis.

Available from the National Technical Information Service, Springfield, VA 22161 as PB81-208183, Price codes: A05 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-088, July 1981. 3 p. R804991

Descriptors: *Viruses, *Disinfection, *Chlorination, *Ozonation, *Ultraviolet radiation, *Wastewater treatment, Effluent, Coxsackie virus, Polio virus, Diurnal variation.

Virus levels before and after disinfection were studied in four full-scale wastewater treatment plants: two used chlorine as the disinfectant, one used ozone, and one used ultraviolet light. A second ozone study was conducted on a pilot scale at one of the treatment plants. Results for the viral content in wastewater effluents indicated no consistent correlation between virus concentrations and any of the traditionally measured indicators of pollution. No seasonal variation of virus concentration was detected in this four-season study. A diurnal variation, however, was noted in one of the plants during two separate samplings: one in December and one in July. Maximum virus concentrations occured in this effluent between 2:00 and 4:00 a.m. for each of these two sampling periods. All three types of polioviruses (1,2 and 3) were shown to be present in the effluents, with poliovirus 1 being the predominant virus type found in both the treated and treated plus disinfected effluents. Coxsackie A9, B1, B2, B3, B4, B5, and B6 were also isolated and identified. Except for coxsackie B5, all virus types were found in the treated as well as the treated plus disinfected effluent. Significantly lower virus isolation rates were encountered after disinfection. Experiments with pure strains and known quantities of attenuated viruses to determine recovery efficiencies indicated that variability in viral seed recovery data, although fairly small in a controlled laboratory environment, is more marked in a field situation. (Moore-SRC)
W82-03005

**TWO-STAGE BIOLOGICAL TREATMENT OF COKE PLANT WASTEWATER,**

Rexnord, Inc., Milwaukee, WI.
R. Osantowski, A. Geinopolos, J. Meverden, and J. Milanowski.

Available from the National Technical Information Service, Springfield, VA 22161 as PB81-240798, Price codes: A11 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-052, September, 1981. 4 p, 3 Fig, 1 Ref.

Descriptors: *Industrial wastewater, *Advanced wastewater treatment, *Biological wastewater treatment, *Activated sludge process, Filtration, Nitrogen removal, Activated carbon, Ammonia, Coke plant wastewater, *Byproducts, Wastewater treatment.

A pilot-plant study of the use of advanced waste treatment methods in upgrading metallurgical cokemaking wastewaters to Best Available Technology (BAT) levels was carried out using mobile treatment units. Three wastewater treatment trains were investigated. In the first treatment train, plant wastewater from downstream of the coke plant cooling tower was passed through a mixing tank, through the first-stage activated sludge system (carbonaceous removal), and then through the second-stage activated sludge system (nitrogen removal). The second treatment train consisted of the first treatment train (bio-oxidation) followed by activated carbon adsorption. The third treatment train included the components of the first treatment train followed by dual-media filtration. Abnormal operating conditions in the coke plant wastewater pretreatment system during the test resulted in ammonia levels as high as 2000 mg/l, making it necessary to dilute the second stage feed before nitrification could be achieved. Ammonia reductions of more than 97% were achieved in the second stage. Activated carbon and filtration effectively removed suspended solids, total organic carbon, color, and thiocyanate. (Moore-SRC)
W82-03029

**LABORATORY STUDIES OF PRIORITY POLLUTANT TREATABILITY,**

Walk, Haydel and Associates, Inc., New Orleans, LA.
J. K. Smith, R. J. Planchet, E. J. Westbrook, and F. J. Zak.

Available from the National Technical Information Service, Springfield, VA 22161 as PB81-231235, Price codes: A07 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-129. September, 1981. 4 Fig, 2 Tab, 2 Ref.

Descriptors: *Industrial wastewater, *Wastewater treatment, *Adsorption, *Steam stripping, Benzenes, Phenols, Chlorinated hydrocarbons, Petroleum industry, Chemical industry, *Cost analysis, Aniline, Priorities.

A wastewater grab sample from a typical medium sized petrochemical manufacturing complex was used for laboratory bench scale treatment tests on five priority pollutants present at significant concentrations. The study focused on carbon adsorption, resin adsorption and steam stripping technologies and developed order-of-magnitude cost relationships for each technology. The results indicate high removal efficiency for the priority pollutants nitrobenzene, p-dichlorobenzene, chlorobenzene, phenol and dinitrotoluene by both carbon adsorption and resin adsorption. Steam stripping was not effective under the test conditions for removal of phenol or dinitrotoluene. The steam stripping data also indicated that removal of the non-conventional pollutant aniline was ineffective. Operating costs for treating streams similar to the stream tested are estimated to be on the order of $2 to $3 per 1000 l for flows of about 1130 l/min. Cost effectiveness may favor use of carbon adsorption over resin adsorption and combination systems appear to offer no economic advantage at pollutant levels present in the sample. (Moore-SRC)
W82-03030

**FEASIBILITY STUDY OF OPEN TANK OXYGEN ACTIVATED SLUDGE WASTEWATER TREATMENT,**

FMC Corporation, Englewood, CO.
K. R. Rakness.

Available from the National Technical Information Service, Springfield, VA 22161 as PB81-213274, Price codes: A04 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-095, July, 1981. 7 p, 1 Fig, 5 Tab.

Descriptors: *Oxygenation, *Activated sludge process, *Wastewater treatment, Municipal wastewater, Effluent, Biochemical oxygen demand, Sludge.

To date, there is one known open tank high purity oxygen activated sludge system on the market, the MAROX system. The system uses a unique bubble shear method for dissolution of pure oxygen to the mixed liquor. The pilot plant used consisted of one oxygenation basin and two clarifiers capable of treating 151 L/min. The system treated primary effluent from a municipal wastewater treatment facility. The influent flow rate was adjusted to attain average aeration reactor detention times ranging from 0.94 to 3.3 hr. The pilot plant operation was conducted in two phases. Treatment performance during both phases was excellent. Final effluent BOD5 concentrations and secondary BOD5 removals averaged less than 20 mg/L and greater than 90%, respectively. No degradation in process removal efficiency occurred, even at organic loadings as high as 1.23 kg BOD5 applied/day/kg mixed liquor suspended solids (MLSS) and volumetric loadings as high as 4.07 kg BOD5 applied/day/cu m of reactor capacity. Better effluent quality was attained by operating at return flow/influent flow ratios between 50 and 60 as opposed to ratios between 30 and 40. No significant nitrification occurred during the test program. Analysis of operations indicated that somewhat less sludge was produced with the oxygen system when compared with typical air sludge production. (Moore-SRC)
W82-03032

**PHYSICAL/CHEMICAL TREATMENT OF COKE PLANT WASTEWATER,**

Rexnord, Inc., Milwaukee, WI.
R. Osantowski, A. Geinopolos, and G. Rollinger.

Available from the National Technical Information Service, Springfield, VA 22161 as PB81-206021, Price codes: A10 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-053, July, 1981. 2 p.

Descriptors: *Industrial wastewater, *Wastewater treatment, *Physicochemical treatment, Chlorination, Filtration, Dechlorination, Activated carbon, Suspended solids, Organic compounds, *Coke plant wastewater.

Selected advanced waste treatment technologies for treating metallurgical cokemaking wastewaters to Best Available Technology (BAT) levels were investigated in a pilot-plant study. Mobile treatment units, operable at a flow rate of 19 1/min, were used. Two physical/chemical treatment trains were studied: alkaline-chlorination/filtration/activated-carbon, and alkaline-chlorination/sodium-bisulfite-dechlorination/filtration. Chlorination was effective in consistently reducing pollutant concentrations to below BAT levels, except for total cyanide. Filtration provided effective polishing of the alkaline chlorinated coke plant wastewater, removing 71% of the influent suspended solids. Suspended solids removal could be increased to 93% of the incoming total chlorine, while sodium bisulfite provided 100% chlorine removal at a bisulfite:chlorine ratio of 2:1. The treatment trains created several volatile organic priority pollutants. Train 1 technologies removed 73% of the volatile organic priority pollutants to non-detectable limits; train 2 technologies were effective in treating only 17% of incoming volatile organic toxics to non-detectable levels. Semivolatile organics were all effectively reduced for train 1. Train 2 also reduced all semivolatile organics to less than 100 micro g/l except for naphthalene. (Moore-SRC)
W82-03033

**TEXTILE WARP SIZE RECLAMATION USING THERMAL PRECIPITATION,**

Auburn Univ., AL.
W. S. Perkins, R. P. Walker, and L. J. Hirth.

Available from the National Technical Information Service, Springfield, VA 22161 as PB81-129041, Price codes: A04 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-80-209, July, 1981. 4 p, 1 Fig.

Descriptors: Textiles, *Recycling, *Water pollution control, *Wastewater renovation, Cost analysis, Waste recovery, Industrial wastewater, Water reuse, Size material removal, *Textile mill wastes.

Virtually all textile yarns which are to be woven into the warp in a fabric are coated with a protective material, called size, during the slashing process, in order to improve the performance of the yarn in the weaving process. In most cases the size material is removed from the woven fabric in the finishing plant. A process to recover and recycle the warp size has the potential to lower the BOD and COD of textile finishing plant effluents more than any other single change in textile processing. A novel method for reclaiming size is based on precipitation of the size material by heating the desize washwater. The method uses hydroxypropyl cellulose (HPC) or hydroxypropyl methylcellulose (HPMC) which are soluble in cool water but insoluble in warm water. Water used for desizing and subsequently separated from the HPC in a recovery system is suitable for reuse in desizing. Strength and elongation of yarns sized with virgin HPC and with reclaimed HPC were not significantly different from those of yarns sized with conventional size. Weaving of HPC-sized yarns in the laboratory was successful. The capital investment for reclaiming HPC using thermal precipitation is much lower than for recovering polyvinyl alcohol size using ultrafiltration. Size reclamation is considered to be an economical approach to chemical and water conservation and will reduce pollution load. (Moore-SRC)
W82-03034

**REMOVAL OF HEAVY METALS AND SUSPENDED SOLIDS FROM BATTERY WASTEWATERS: APPLICATION OF HYDROPERM CROSS-FLOW MICROFILTRATION,**

Hydronautics, Inc., Laurel, MD.
N. I. Shapirc, H. L. Liu, J. Baranski, and D. Kurzweg.

Available from the National Technical Information Service, Springfield, VA 22161 as PB81-234833, Price codes: A05 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-147, September, 1981. 5 p, 3 Fig.

Descriptors: *Heavy metals, *Suspended solids, *Wastewater treatment, *Filtration, *Industrial wastewater, Lead, Neutralization, Lime, Battery wastewater.

The microfiltration system is a treatment process which employs a physical principle of treatment for suspended solids removal after chemical precipitation. The principal element of the system is a thermoplastic tubular filter constructed with a controlled porosity in the micron-size range. Relatively low feed pressures are employed. Laboratory and full-scale field demonstrations were conducted to demonstrate the applicability of the microfiltration system to lead-acid battery production wastewaters. The waste from the battery manufacturing facility is a mixture of sulfuric acid from occasional dumping of open-tank formation of the anode and cathode battery plates, rinse water from the plate washing facilities, and floor drains from throughout the plant. The combined total daily waste production is approximately 75,000 l/day. The waste acid and rinse water mixture is neutralized with high calcium lime to convert the soluble metals to a suspended hydroxide form. Suspended solids in the feed which exceeded 150,000 ppm were typically reduced to 3 ppm in the permeate. Lead in the feed in the range of several hundred parts per million was typically reduced to 0.02-0.1 ppm. Other toxic heavy metals were removed with comparable effectiveness. (Moore-SRC)
W82-03037

**FINE COAL-REFUSE SLURRY DEWATERING,**

Bureau of Mines, Spokane, WA. Spokane Research Center.
R. R. Backer, and R. A. Busch.

Available from the National Technical Information Service, Springfield, VA 22161 as PB82-160268, Price codes: A02 in paper copy, A01 in microfiche. Bureau of Mines Report of Investigation 8581, 1981. 21 p, 11 Fig, 7 Tab.

Descriptors: *Slurries, *Dewatering, *Mine wastes, *Coal, Flocculation, *Wastewater treatment, Polymers, Drains, Lime.

Under normal operating conditions and with state-of-the-art decant construction, current impoundments never achieve adequate dewatering and stabilization of fine coal-refuse slurry. Bench-scale and field tests were carried out to evaluate dewatering using chemicals and various types and combinations of drains in natural earth impoundments. About 40 lb of lime and 2 lb of polymer per ton of dry solids were mixed with the underflow from preparation-plant thickener. Clear, free water was immediately liberated from the slurry. The percent solids by weight of the slurry increased from about 17 to 30 immediately, and after 5 days increased to 45%. In contrast, untreated slurry took weeks to settle, and the surface water remained turbid. The low permeability of the flocculated slurry precludes rapid dewatering without some type of drainage system and supplemental surface decanting to remove the clear water at a rate that would permit continuous operation. Vertical fabric drains seemed to be a little more effective than vertical sand drains: on the basis of comparative permeabilities, it is assumed that their advantage was derived from a larger surface-area contact with the slurry. To insure reclamation of water and prevent possible ground-water contamination it would be advisable to have an impervious soil base with a bottom drain of sand or bottom ash. (Moore-SRC)
W82-03049

**RESTORING GROUND WATER QUALITY FOLLOWING IN SITU LEACHING,**

Bureau of Mines, Twin Cities, MN. Twin Cities Research Center.
D. R. Tweeton.

Available from the National Technical Information Service, Springfield, VA 22161 as PB82-104753, Price codes: A06 in paper copy, A01 in microfiche. In: In Situ Mining Research, Proceedings: Bureau of Mines Technology Transfer Seminar, Denver, CO, August 5, 1981, Bureau of Mines Information Circular 8852, 1981. p 27-37, 9 Tab, 2 Ref.

Descriptors: *Groundwater pollution, *Water pollution control, *Wastewater treatment, *Leaching, Sludge, Reverse osmosis, Injection wells, Evaporation ponds, Uranium.

The waste solution from in situ uranium leaching and from postleaching restoration can be disposed of in either a deep disposal well or an evaporation pond. Generally, deep disposal wells have been used in Texas and evaporation ponds in Wyoming. Injection of waste through a deep well into a zone that does not contain useful water offers the advantage that the waste is completely removed from the biosphere. Deep well disposal is limited to waste solutions that will not plug the injection zone by the precipitation of solids in reactions between the solution and the matrix of the host aquifer. An important disadvantage of solar evaporation ponds is that as evaporation occurs, a sludge remains and there are stringent regulations governing the disposal of the sludge. The waste stream from leaching or from restoration can be treated to produce two streams: purified water, and a concentrated brine. The purified water can be reused, thereby reducing the total consumption of water, and the disposal system does not require as large a capacity. The surface treatment technique that has been used for in situ leaching wastes is reverse osmosis. Other treatment methods that are potentially useful are electrodialysis, distillation, ion exchange, foam separation, and freeze separation. Ground water restoration appears to be a bigger problem than was previously thought. Field testing has shown that complete restoration, as defined by State regulatory agencies, has not been attained with reasonable degrees of flushing at any of the sites studied. (Moore-SRC)
W82-03050

**FULL-SCALE EVALUATION OF HIGH RATE SCREENING DEVICES FOR TREATMENT OF SANITARY SEWAGE BY-PASS FLOW,**

Ontario Ministry of the Environment, Toronto.
H. Kronis, and F. Tonelli.

1980. 145 p, Fig, Tab, 11 Ref, Append.

Descriptors: *Suspended solids, *Nutrients, *Water quality, *Sewage, Centrifugal wastewater concentrator, BOD5, Hydrasieve, Rotostrainer, Primary treatment, Secondary treatment, Urban drainage, Canada, *Ontario, *Wastewater treatment.

The performance of four fine-mesh high-rate screening devices treating combined sewage under wet and dry weather conditions were evaluated. The units tested were: a 1.5-m (60-inch) diameter Centrifugal Wastewater Concentrator (CWC) with 105-micrometre apertures; a 1.5-m (60-inch) long rotating horizontal drum screen (Rotostrainer) with 500-micrometre apertures; and two stationary inclined screens, a 0.6-m (24-inch) wide DSM and a 1.8-m (72-inch) wide Hydrasieve, having 305 and 762-micrometre apertures, respectively. The study was conducted during 1974/75 at the Belleville, Ontario, Water Pollution Control Plant, where influent sewage is subject to substantial infiltration, dilution, and flow peaking during wet weather. Hydraulic capacity and pollutant removal depended largely on the type of screening device, the screen aperture size, and the availability of an effective backwash system. Hydraulic capacities were between 0.78 to 2.4 cu m/sq m per min (16 and 50 gal/min per sq ft). Typical mean pollutant removals obtained during storm events with first flush conditions were between 5 and 32 percent for suspended solids, 5 and 24 percent for BOD5, and 23 and 79 percent for settleable solids. In general, pollutant reductions were substantially less in dry weather. Operating costs were estimated to be between 0.13 and 4.2 cents per cubic metre (0.6 and 19 cents per 1000 gallons) treated depending on, among other factors, installed capacity, the number of hours of operation, and the device evaluated. It was concluded that screening had potential for the reduction of pollutants in combined sewer flows. (WATDOC)
W82-03110

**MASS PRODUCTION OF FRESHWATER ROTIFERS ON LIQUID WASTES I. THE INFLUENCE OF SOME ENVIRONMENTAL FACTORS ON POPULATION GROWTH OF BRACHIONUS RUBENS EHRENBERG 1838,**

Kernforschungsanlage, Juelich (Germany, F.R.) Inst. fuer Biotechnologie III.
M. Schluter, and J. Groeneweg.

Aquaculture, Vol 25, No 1, p 17-24, July, 1981. 4 Fig, 10 Ref.

Descriptors: *Rotifers, *Animal wastes, *Aquaculture, *Wastewater treatment, Ponds, Algae, Manure, *Farm wastes, Nitrites, Dissolved oxygen, Oxygen, Growth rates, Hydrogen ion concentration.

The effects of environmental factors on the rotifer Brachionus rubens were studied for two reasons: to control the undesirable growth of rotifers in an algal pond for treatment of pig manure and to test the possibility of continuous mass production of rotifers in algal pond effluents. Results indicate that rotifers tolerated oxygen concentrations as low as 1.5 mg per liter for long periods. Rotifers adapted to nitrites had population growth rates of 70-90% of controls at nitrite concentrations of 15 mg per liter or less. These growth rates declined steadily to 15% at 30 mg per liter. Addition of sodium chloride showed that some animals survived at levels of 4 g per liter. Growth was greater than 85% at 1 mg per liter NaCl or less. Rotifers did not survive at pH $< 4.5$ or $> 9.5$. Growth reached a peak at pH 7. Rotifer growth could be controlled by stopping the wastewater inflow to the pond on sunny summer days, when pH levels of 11 are possible. Conversely, pH must be maintained at 6-8 for optimum rotifer growth. (Cassar-FRC)
W82-03114

**USE OF A FRACTIONAL DESIGN TO EVALUATE INTERACTIONS OF ENVIRONMENTAL FACTORS AFFECTING BIODEGRADATION RATES,**

Wyoming Univ., Laramie. Dept. of Zoology and Physiology.
T. E. Fannin, M. D. Marcus, D. A. Anderson, and H. L. Bergman.

Applied and Environmental Microbiology, Vol 42, No 6, p 936-943, December, 1981. 4 Fig, 4 Tab, 19 Ref.

Descriptors: *Phenol, *Biodegradation, *Factor analysis, Degradation, *Wastewater treatment, Experimental design.

Fractional factorial design was used to evaluate the main and interactive effects of six environmental factors on biodegradation of phenol. This procedure reduced the number of shake-flask experiments to 81, compared with the 324 necessary with conventional factorial designs. The six factors investigated were: (1) amount of phenol substrate, (2) amount of bacterial inoculum, (3) filtration of inoculum, (4) type of basal salts medium, (5) initial pH of basal salts medium, and (6) flask closure. Factors (1), (2), and (4) had significant single effects on biodegradation. Increasing phenol concentrations in the substrate decreased the maximum degradation rate. Increasing the amount of bacterial inoculum increased the maximum degradation rate. The highest maximum degradation rates were observed in R and V medium, used for determining phenol-degradation bacteria. Interactive effects were found for factors (2) and (3) and for factors (2) and (5). (Cassar-FRC)
W82-03117

**RECOVERY OF INDIGENOUS ENTEROVIRUSES FROM RAW AND DIGESTED SEWAGE SLUDGES,**
Surrey Univ., Guildford (England). Dept. of Microbiology.
M. R. Goddard, J. Bates, and M. Butler.
Applied and Environmental Microbiology, Vol 42, No 6, p 1023-1028, December, 1981. 4 Fig, 2 Tab, 19 Ref.

Descriptors: *Viruses, *Sludge digestion, Digestion, Fate of pollutants, Sludge disposal, Mesophilic digestion, Thermophilic digestion, Anaerobic digestion, *Raw wastewater.

Removal of enteroviruses by three types of raw sewage sludge digestion was determined. Treatments were: (A) 30-35 days of anaerobic-mesophilic digestion, followed by 30 days consolidation; (B) 24 hours consolidation, 30-35 days anaerobic-mesophilic digestion, followed by 30-40 days of consolidation; (C) 25-30 days of anaerobic-mesophilic digestion followed by 3-4 years of drying in beds; and (D) a pilot plant thermophilic-aerobic digestion treatment. The pilot plant was most effective and fastest in reducing titers of infectious viruses. Reductions of viruses after consolidation (75th day) were (A), 88.5%, and (B), 84.2%. Little reduction in virus titer took place in Treatment (C) by the 35th day, when sludge was applied to land. Mesophilic digestion alone did not reliably reduce virus titers, possibly as a result of inadequate mixing during daily sludge additions. However, the consolidation process decreased viruses to a greater extent. (Cassar-FRC)
W82-03121

**THE EFFECT OF NI(II) ON NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
P. G. Trahern, W. R. Knocke, and J. H. Sherrard.
AIChE Symposium Series, Vol 77, No 209, p 171-176, 1981. 5 Fig, 2 Tab, 12 Ref.

Descriptors: *Nitrification, Activated sludge, Sludge, *Activated sludge process, *Wastewater treatment, *Nickel, Heavy metals, Biological treatment.

The study was accomplished by operating continuous flow, laboratory scale activated sludge units over a wide range of process operating conditions. The units were fed a soluble, reproducible wastewater in which the COD:TKN ratio was varied and the concentration of Ni(II) was varied. Data were collected under steady state conditions and were analyzed to assess the effect of Ni(II) on the degree of nitrification, COD removal efficiency, microbial yield coefficient and microbial maintenance coefficient. Nitrification was inhibited at an influent Ni(II) of 1.0 mg/l, a COD:TKN ratio of 3.7:1 and influent COD of 400 mg/l. Efficiency of organic removal as measured by the COD test was not affected by the presence of an influent Ni(II) concentration of 1 mg/l. This indicates that the threshold toxicity concentration is higher than 1 mg/l. No effect on nitrification or COD removal efficiency was noted with an influent Ni(II) concentration of 0.5 mg/l for substrates containing COD:TKN ratios between 2.4:1 and 7.3:1 with an influent COD of 400 mg/l. This observation, coupled with that of the prior conclusion, indicates that the nitrification threshold toxicity concentration proceeded at a very high efficiency at pH values as low as 4.9. The presence of Ni(II) was found to influence the values of the biokinetic coefficients. (Baker-FRC)
W82-03124

**TREATMENT OF METAL CONTAINING WASTEWATER WITH CALCIUM SULFIDE,**
General Electric Co., Schenectady, NY.
B. M. Kim.
AIChE Symposium Series, Vol 77, No 209, p 39-48, 1981. 5 Fig, 5 Tab, 11 Ref.

Descriptors: *Wastewater treatment, *Heavy metals, Sulfides, Precipitation, Industrial wastes, *Calcium sulfide.

This paper discusses sulfide precipitation methods, process development, results of treatability studies using wastewater samples, and examples of process applications in wastewater treatment plants. Sulfide precipitation is very effective for the removal of heavy metals such as cadmium, copper, lead, silver and zinc. The method works in the presence of chelating agents and removes metals to extremely low concentrations. The calcium sulfide slurries, prepared by reacting lime with hydrogen sulfide or sodium hydrosulfide, are effective sulfide sources. The addition of calcium sulfide can be controlled simply in most cases by measuring the pH. The processes employing such techniques have been demonstrated in bench scale experiments using wastewater samples. The two stage process may be employed when the wastewater contains a large amount of iron and nontoxic suspended solids. The major advantage of the process is the significant reduction achieved in toxic sludge volume when a large amount of nontoxic materials is present in the wastewater. The two stage process requires a capital cost higher than the single stage process. Since the solid/liquid separation in the first stage is not as critical as the second stage, a less expensive clarification system may be employed in the first stage. (Baker-FRC)
W82-03125

**TREATMENT OF COOLING TOWER BLOWDOWN,**
Bechtel Corp., San Francisco, CA.
A. N. Rogers, M. C. Weekes, S. C. May, and E. H. Houle.
AIChE Symposium Series, Vol 77, No 209, p 239-248, 1981. 3 Fig, 6 Tab, 9 Ref.

Descriptors: *Cooling water, *Reverse osmosis, *Vapor compression distillation, *Wastewater treatment, Dissolved solids, Crystallization, Evaporation, Ponds, Scaling, *Powerplants, Distillation, Steam, Surfactants, Brines.

Three processes for treatment of powerplant cooling tower blowdown are described and compared: reverse osmosis, vapor compression, and vertical tube evaporation. Dissolved salts are concentrated and wasted to ponds. In reverse osmosis the feed must be pretreated to reduce the concentration of scale-formers. This involves addition of sodium carbonate-lime slurry for precipitation of salts, Cl for controlling bacterial growth, acid for pH adjustment, sodium bisulfite for dechlorination, and sodium hexametaphosphate to obstruct the growth of scale crystals. About 75% of the original feed is recovered as usable water, containing 6-7% of the initial salt concentration. Vapor compression evaporation uses a vertical tube evaporator in which the liquid descends as a thin film on the inside of tubes. Compressed steam in contact with the outside of these tubes evaporates the feed water. Brine is recycled to the top for further evaporation. A vapor compressor withdraws the vapor generated and condenses it on the outside of the evaporation tubes. The process is highly energy-effective. The vertical tube foaming evaporator, not yet in commercial operation, consists of a conventional vertical tube evaporator followed by a smaller evaporator to concentrate the brine to the crystallizing stage. The small amount of surfactant added to the feed reduces scale formation, lowers hydrostatic losses, and improves heat transfer. No process was superior to the other two in all respects--energy use, product water quality, operating costs, ponding requirements, sensitivity to upsets, or ease of construction. (Cassar-FRC)
W82-03126

**TREATABILITY OF TOXIC WASTEWATER POLLUTANTS BY SOLVENT EXTRACTION,**
Environmental Protection Agency, Washington, DC.
S. T. Hwang.
AIChE Symposium Series, Vol 77, No 209, p 304-315, 1981. 1 Tab, 14 Ref.

Descriptors: *Organic compounds, *Solvent extraction, *Distribution coefficients, *Wastewater treatment, Chlorinated hydrocarbons, Pesticides, Amines, Phthalates, Aromatic compounds, Phenols, Polynuclear aromatic hydrocarbons, Activated carbon, Reviews, Toxins.

A review of the literature on solvent extraction of organic priority pollutants from wastewater is presented. This method can remove up to 99.9% of some organic toxic pollutants which are difficult to remove by steam or inert gas stripping or activated carbon adsorption. Capital expenditures for a 400 gpm solvent extraction system are given as $2 million. Part of this cost may be offset by recovery of marketable organic compounds. Tables give distribution coefficients for 89 organic pollutants in the following solvents: tricresyl phosphate, undecane, methyl isobutyl ketone, tridecane, benzene, isobutylene, isobutane, n-butyl acetate, isobutyl acetate, diisopropyl ether, octanol, cumene, mesityl oxide, methyl ethyl ketone, ethyl acetate, ethyl ether, ethyl benzene, n-hexanol, EDC, toluene, xylene, and n-hexane. The pollutants include chlorinated hydrocarbons, phenols, aromatic compounds, polycyclic aromatic compounds, amines, phthalates, and pesticides. (Cassar-FRC)
W82-03127

**FREEZE CRYSTALLIZATION APPLICATIONS FOR WASTEWATER RECYCLE AND REUSE,**
Heist Engineering Corp., Wilmington, NC.
J. A. Heist.
AIChE Symposium Series, Vol 77, No 209, p 259-272, 1981. 4 Fig, 6 Tab, 29 Ref.

Descriptors: *Industrial wastewater, *Crystallization, *Water reuse, *Wastewater treatment, Freeze crystallization, Chemical wastewater, Solubility, Cooling water, Acids, Metal-finishing wastes, Organic compounds, Separation techniques.

Industrial wastewater treatment by freeze crystallization has many advantages: no pretreatment, minimal corrosion of equipment, high level of water recovery, enhanced byproduct recovery, small volume of final waste, and thermodynamics favorable to energy savings. The versatile process may be adapted to many conditions. The basic process steps are: crystallization by direct or indirect contact with the refrigerant, crystal separation (often in a wash column), melting for energy conservation, and heat recovery from the melted product for additional energy savings. Steps are described for adapting freeze crystallization to a new application: determining solid-liquid equilibria, developing flow diagrams and mass and energy balances, and analyzing economic feasibility. This planning process is illustrated for freeze crystallization treatment of wastewaters from three applications: cooling tower blowdown, pickle liquor for preparing metal surfaces, and wash waters from terephthalic acid manufacture. (Cassar-FRC)
W82-03128

**SLUDGE MANAGEMENT PROCESS INTEGRATION,**
Cornell Univ., Ithaca, NY.
R. I. Dick.
AIChE Symposium Series, Vol 77, No 209, p 214-219, 1981. 5 Fig, 4 Ref.

Descriptors: *Sludge disposal, *Economic aspects, *Wastewater treatment, Sludge thickening, Sludge drying, Sludge, Activated sludge, Waste management.

Means for rationally integrating processes for sludge management are considered. Categories of processes include those for thickening, conditioning, dewatering, stabilizing, inactivating, combusting, reusing, storing, transporting, and disposing of sludge. A variety of different individual processes can be used within each category. Several advantages can be gained in designing a management scheme by considering important interactions between sludge management processes and designing and operating sludge management facilities to minimize adverse interactions and maximize favorable interactions to achieve overall least cost. The physical properties of sludges are principal factors influencing the cost of sludge management. Given the properties of sludge as they are currently produced, substantial attention to physical properties is warranted in process design, and research is needed on means for controlling and improving the physical properties of sludge at its source and for altering physical properties following sludge

production. Specific findings suggest that gravity thickeners should be built larger than is generally the practice, whereas the optimum size of anaerobic digesters is usually the minimum required for operational stability. Sludge irradiation results in improvement in sludge dewatering properties, and thus a reduction in the net costs. (Baker-FRC)
W82-03130

**BIOLOGICAL NITROGEN CONTROL OF INDUSTRIAL WASTEWATER,**
Dorr-Oliver Inc., Stamford, CT.
P. M. Sutton, and T. R. Bridle.
AIChE Symposium Series, Vol 77, No 209, p 177-185, 1981. 9 Fig, 3 Tab, 15 Ref.

Descriptors: *Wastewater treatment, *Denitrification, *Industrial wastewater, Nitrogen, Nitrification, Carbon, Sludge, Activated sludge process, Coke plant wastewater, Organic compounds, Steel industry, Plastics wastewater.

Results are presented from studies undertaken as part of the Canadian federal government regulation development activities for the organic chemical industry and the iron and steel industry involving the application of the pre-denitrification-nitrification process configuration. This configuration will be the most economical alternative for the biological treatment of industrial wastewaters such as nylon intermediates wastewater containing high concentrations of organic carbon and inorganic nitrogen. Organic carbon and nitrate reduction are accomplished in an anoxic first stage reactor, with the organics present in the wastewater providing the carbon and energy for denitrification. The conversion of ammonia to nitrate, or nitrification, and oxidation of any biodegradable organics not removed in the first stage, is accomplished in the aerobic second stage. In demonstration studies the single sludge pre-denitrification-nitrification system was able to achieve complete nitrification and denitrification of coke plant wastewater from Dominion Foundries and Steel Limited, provided dilution is practiced or powdered activated carbon is added at 33 to 50 mg/liter. The minimum aerobic solids retention time required to achieve complete nitrification of diluted wastewater at 22 to 24 degrees C was 22 days. In the treatment of high strength wastewater, Nitrobacter inhibition can be overcome by addition of 50 mg/liter of PAC to the feed. Dilution of the wastewater did not eliminate Nitrobacter inhibition. The organic carbon present in the wastewater can be used as the carbon and energy source for the denitrification reaction. No supplemental organic carbon is needed if the feed FOC/TN ratio is greater than 3.5. (Baker-FRC)
W82-03131

**NITRIFICATION USING THE ROTATING BIOLOGICAL CONTACTOR,**
Army Environmental Hygiene Agency, Aberdeen Proving Ground, MD.
R. D. Miller, J. A. Hitdlebaugh, C. I. Noss, and E. D. Smith.
AIChE Symposium Series, Vol 77, No 209, p 186-195, 1981. 7 Fig, 33 Ref.

Descriptors: *Nitrification, *Wastewater treatment, Acidity, Temperature effects, Biological oxygen demand, Oxidation, Rotating biological contactor.

This paper reports on nitrification using the rotating biological contactor (RBC) process based on both pilot and full scale experiences with domestic wastewaters. It offers a literature review and a discussion of the nitrification reaction. Selection of design criteria is detailed, and scale-up problems are outlined. The importance of environmental conditions such as pH and temperature as well as other variables is discussed for treatment plant design relative to any wastewater. A list of specific conclusions regarding the RBC process for nitrification is presented. The RBC process can be an effective design for combined secondary treatment and nitrification when the following facts are considered. First, pH levels influence the rate of nitrification and the location where it begins. Adjusting chemical feed to increase pH levels to at least 7.0 in all RBC stages increases the rate of nitrification and decreases RBC surface area requirements. This produces more effective design and consistent ammonia removal. Wastewater temperature affects both secondary treatment and nitrification within RBC stages. Nitrification rates are more sensitive to low temperatures than organic removal rates. Dissolved oxygen, which may be a limiting condition, can be easily corrected by supplemental aeration during organic removal. Filtration after the RBC process will be needed to meet total BOD limits of 10 mg/liter or less. (Baker-FRC)
W82-03132

**PREDICTION OF THE FATE OF ORGANIC COMPOUNDS IN BIOLOGICAL WASTEWATER TREATMENT SYSTEMS,**
Purdue Univ., Lafayette, IN. School of Civil Engineering.
R. F. Wukasch, C. P. L. Grady Jr., and E. J. Kirsch.
AIChE Symposium Series, Vol 77, No 209, p 137-143, 1981. 11 Fig, 4 Ref.

Descriptors: *Wastewater treatment, *Organic compounds, *Biological wastewater treatment, Model studies, Municipal wastewater, Degradation, Sludge, Toxicity, Testing procedures.

A testing protocol was developed and evaluated which would determine and predict the fate of specific organic compounds in conventional biological wastewater treatment systems. This protocol was designed to determine the toxicity to aerobic biological systems and anaerobic sludge digestion systems of the specific compound; to quantitate the adsorption and stripping losses of the compound; to develop kinetic information allowing prediction of effluent quality as a function of the solids retention time of the biological treatment system; and to estimate the extent of biodegradation of the compound. A description is offered of the protocol using pentachlorophenol as the test compound. The protocol focuses on the toxicity to activated sludge systems and anaerobic digestion, partitioning and intermediate transport including volatilization and sorption, and the biodegradability, including kinetics and effluent quality, as a function of solids retention time. If the organic compound being tested is biodegradable, the protocol can be used to develop kinetic data which are useful in predicting the effluent concentration of the specific compound from a given wastewater treatment plant as a function of the cell residence time. Also included in the protocol are methods for determining the amount of a compound which can be adsorbed onto biomass solids or air stripped, and methods for predicting losses of the compound from full-scale installations. (Baker-FRC)
W82-03133

**FACTORS INFLUENCING BIOLOGICAL NITRIFICATION OF STEEL INDUSTRY WASTEWATERS,**
Pittsburgh Univ., PA. Dept. of Civil Engineering.
R. D. Neufeld, A. J. Hill, and J. H. Greenfield.
AIChE Symposium Series, Vol 77, No 77, No 209, p 151-158, 1981. 7 Fig, 1 Tab, 12 Ref.

Descriptors: *Wastewater treatment, *Nitrification, *Biological wastewater treatment, Acidity, Temperature effects, Industrial wastes, *Steel industry, Industrial plants.

Basic studies were conducted into possible causes of biological nitrification process instability as currently observed in many industrial wastewater operations in order to eventually propose rational and pragmatic process operational alternatives for the biological oxidation of ammonia. It is noted that pH acts in conjunction with total ammonia levels to cause the free ammonia concentration in solution to act as a master variable influencing nitrification biokinetics. Free ammonia level acts as a substrate inhibitor to nitrification biokinetics, with a maximum in specific nitrification removal rates existing at free ammonia levels of about 10 mg/liter. Free ammonia begins to inhibit nitrification at 10 mg/l. Suggested sludge ages to maintain effective nitrification when free ammonia is neither limiting or inhibitory are 15-18 days for a pH of 7.0; 9-12 days for a pH of 8.0; and 12-15 days for a pH of 9.0. Nitrification biokinetics are very sensitive to elevated temperatures. Wastewater temperatures should be kept below 30 degrees C to assure stable nitrification, producing effluents of 10 mg/liter ammonia or less. Trace organics act as toxic inhibitors to nitrification biokinetics. Phenol, for example inhibited the maximum rate of specific ammonia utilization in a manner proportional to the square root of the phenol concentration. (Baker-FRC)
W82-03134

**TROUBLESHOOTING AND CONTROL OF NITRIFICATION WASTEWATER TREATMENT SYSTEMS,**
Engineering-Science, Inc., Austin, TX.
D. L. Ford.
AIChE Symposium Series, Vol 77, No 209, p 159-170, 1981. 10 Fig, 4 Tab, 14 Ref.

Descriptors: *Wastewater treatment, *Nitrification, *Design criteria, Operating policies, Management planning, *Biological wastewater treatment.

The concepts of biological nitrification are discussed, design aspects are considered, and operational techniques needed for troubleshooting and process control are outlined. Biological nitrification systems include both fluidized, activated sludge type reactors and fixed growth reactors, the latter including trickling filters and rotating biological contactors. Some of the more prevalent factors which influence nitrification include temperature, dissolved oxygen levels, pH, alkalinity, substrate loading, and sludge age and inhibition of nitrifiers. Many design concepts for nitrification systems have been developed over the years, but most have centered around some modification of fluidized activated sludge systems. Many approaches have been proposed in defining nitrification kinetics to establish basic criteria for design of fluidized nitrifying systems. Nitrification can be achieved in a single stage carbonaceous/nitrification system. The retention time or sludge age must be sufficient to enable the nitrification reactions to approach completion. The use of side stream aeration and two stage aeration has been shown to be nitrification-effective, with perhaps greater process reliability during cold weather periods and upset conditions. The most significant factors which relate to operational control and troubleshooting include defining and maintaining nitrifying population, dissolved oxygen control, alkalinity and pH control, influent transients, and the detection and control of inhibitory substances. It is important in any treatment system to detect process problems and offer remedies in the shortest time possible. (Baker-FRC)
W82-03135

**THE REDUCTIVE TREATMENT OF INDUSTRIAL WASTEWATERS. I. PROCESS DESCRIPTION,**
Envirogenics Systems Co., El Monte, CA.
K. H. Sweeny.
AIChE Symposium Series, Vol 77, No 209, p 67-71, 1981. 4 Fig, 2 Ref.

Descriptors: *Wastewater treatment, *Chemical reduction, Economic aspects, Management planning, Industrial wastes, Toxicity, Chemical reactions, Organic compounds, *Industrial wastewater.

Many toxicants found in waste streams from chemical industry plants can be successfully degraded by chemical reduction using a catalyzed metal powder as the reductant. In particular the process is useful for toxicants dissolved in water, which cannot be removed by physical means. It is common to achieve degradation to 1 microgram/liter or less. This level of contamination is safe for discharging the waters. The process is simple, effective and economical. Catalyzed iron, zinc, or aluminum powders have been effectively employed as reductants by such mechanisms as hydrogenolysis, hydroxylation, saturation of aromatic structure, condensation, ring opening, and rearrangement to change the toxicants to an innocuous form. Wastewater to be so treated may be trickled through a bed of the reductant which is diluted with an inert solid so as to give suitable retention

and flow properties, or preferably with a bed of the reductant fluidized by the aqueous waste solution. Retention times of about 5 minutes at ambient temperatures and flow rates as high as 0.9 cubic meters per minute per square meter have been achieved. The degradation of hexachlorocyclopentadiene and nitrophenol are cited as examples of the process. The process may be designed using a pump, flow control system and fluidized bed reactor. The treatment cost is estimated to be significantly lower than that of carbon sorption methods. (Baker-FRC)
W82-03137

**THE REDUCTIVE TREATMENT OF INDUSTRIAL WASTEWATERS. II. PROCESS APPLICATIONS,**
Envirogenics Systems Co., El Monte, CA.
K. H. Sweeny.
AIChE Symposium Series, Vol 77, No 209, p 72-78, 1981. 7 Tab, 6 Ref.

Descriptors: *Industrial wastes, *Chemical reduction, *Wastewater treatment, Chemical reactions, Toxicity, Organic compounds, *Industrial wastewater.

Several applications of chemical reduction in the treatment of chemical plant toxic waste streams are described. In general the toxicants are chemically changed to a form which is innocuous to the environment, rather than remaining in a concentrated solution or being discharged to the air. Trihalomethanes such as chloroform and bromoform and their intermediates were degraded in a 6 month program, from an average of 242 micrograms per liter to well below the control level set by the Environmental Protection Agency, with 75% of the tested samples reading below 5 micrograms per liter. Trichloroethylene reduction was accomplished, with a decrease in contaminant content from 280 to 3.9 micrograms/liter. Similar reductions were noted for trichloroethane and tetrachloroethane and tetrachloroethylene. Reductive tests with aqueous solutions of chlorobenzene appear to demonstrate both that the material is substantially degraded and that the product is mainly cyclohexanol. Successful degradation of a PCB waste to detection limits was shown, as well as degradation of chlordane. The chlorinated phenoxyacetic acid derivatives were substantially degraded, as was Kepone. The s-triazine derivative atrazine was 90% degraded. N-Nitrosodimethylamine was degraded to detection limits, and di- and trinitrophenols were substantially reduced. The wide range of applicability of the process, the low operating and capital costs, and its effectiveness suggest that reductive degradation may be a promising solution to many waste problems. (Baker-FRC)
W82-03138

**OZONE FOR THE TREATMENT OF HAZARDOUS MATERIALS,**
Jacobs Engineering Group, Washington, DC.
R. G. Rice.
AIChE Symposium Series, Vol 77, No 209, p 79-107, 1981. 7 Fig, 14 Tab, 83 Ref.

Descriptors: *Hazardous materials, *Ozonation, Disinfection, Water treatment, Industrial wastes, *Heavy metals, Oxidation, Cyanides, Sulfides, Industrial wastes, Wastewater treatment, Wastewater disposal.

The known aqueous reactions of ozone with both organic and inorganic chemicals listed on the hazardous materials list are discussed in terms of the ability of ozone to destroy the hazardous compound. Other reactions are considered in which ozone is known to simply convert one specific hazardous material into another. Ozone oxidations in aqueous media are usually dependent on pH. At higher pH ranges of 8 to 9 the ozone decomposes to form hydroxyl free radicals. At low pH, ozone reacts as the free ozone molecule, usually oxidizing at slower rates than at elevated pH. At low pH, amine-nitrogen atoms are protonated and stabilized to oxidation at this point in the molecular structure. Unsaturated aliphatics are generally readily reactive with ozone unless halogenated to high levels. Saturated aliphatics are unreactive. Benzene is slowly oxidized and other aromatics are generally easily oxidized by ozone except when electron-withdrawing substituents are present on the ring. Heavy metals can be oxidized to their highest state by ozone. Easily oxidized hazardous inorganic anions such as cyanide, sulfide, and thiocyanate can be destroyed by ozonation. Ozonation in the presence of UV radiation, ultrasound and/or hydrogen peroxide causes organic oxidations to proceed at significantly increased rates. Ozonation of organics rarely proceeds completely to carbon dioxide and water. Ozonation of some pesticides yields other hazardous products, some of which are stable to further ozonation. (Baker-FRC)
W82-03139

**EVALUATION OF TEMPERATURE EFFECTS IN AERATED BIOTREATERS,**
McKinsey and Co., Amsterdam, (Netherlands).
M. M. Friedman, and H. van Doesburg.
AIChE Symposium Series, Vol 77, No 209, p 112-121, 1981. 7 Fig, 4 Ref.

Descriptors: *Wastewater treatment, *Model studies, *Temperature effects, Aeration, Aerators, *Biological treatment, Biological wastewater treatment, Mathematical model.

To better quantify the temperature phenomenon in biotreating of wastewater, the factors that determine the temperature in the aeration basin have been studied, using a literature model. Testing of this model on data from eight different industrial biotreating systems gave evidence that the measured aerator temperatures could be adequately predicted by the model to within 1 to 3 degrees C. A subsequent parameter sensitivity analysis of the model led to a general, simplified correlation of the heat exchange characteristics of the eight treatment systems. Analysis of the non-steady-state version of the model showed that seven of the eight systems respond fairly quickly to changes in ambient or operating conditions, these changes being noted in less than one day's time. Such analysis can be used to determine various temperature control operating strategies as well as to provide guidance in the design of biotreatment systems. Seasonal changes in temperatures should be taken into account in setting up wastewater effluent quality standards. (Baker-FRC)
W82-03140

**INTERMITTENT BIOLOGICAL WASTE TREATMENT SYSTEMS-PROCESS CONSIDERATIONS,**
New South Wales Univ., Kensington (Australia).
M. C. Goronsky, D. Barnes, and R. L. Irvine.
AIChE Symposium Series, Vol 77, No 209, p 129-136, 1981. 10 Fig, 5 Tab, 16 Ref.

Descriptors: *Wastewater treatment, *Activated sludge process, Sludge, Design criteria, Operating policies, Maintenance, Management planning, Oxygen uptake, *Biological wastewater treatment.

This paper reports on full scale activated sludge systems which are operated over a range of loading conditions. Conventional activated sludge and continuously fed, sequentially aerated and decanted plants were studied under similar overall loading conditions. The performance of each system was measured in terms of oxygen utilization rate and effluent quality and was related to the short term loading on the plants as expressed by an instantaneous food to microorganisms ratio. Laboratory studies supplemented the full scale plant results. Continuously fed, intermittently aerated and decanted activated sludge systems provide an effective method of damping organic and hydraulic load transients. The biomass response of these completely mixed systems was significantly lower than that determined in the continuous conventional activated sludge plant. Single tank treatment systems contain a high mass of sludge available to adsorb and metabolize the influent organic loads. In a conventional continuous activated sludge plant the system is designed such that the capacity of the aerobic biological reactor corresponds to only 4 to 8 hr retention. Additionally, a proportion of the total sludge is contained in the secondary sedimentation tank, so that it can be removed from the wastewater. In the single tank systems retention, and sludge is not removed for separate clarification. Thus the response of these systems to increased organic loads will be well damped due to the capacity of the system. (Baker-FRC)
W82-03141

**ENERGY MINIMIZATION AT METRO DENVER SEWAGE DISTRICT,**
Metropolitan Denver Sewage Disposal District No. 1, CO.
W. E. Korbitz.
AIChE Symposium Series, Vol 77, No 209, p 21-24, 1981.

Descriptors: *Wastewater treatment, *Management planning, Economic aspects, *Energy conservation, Fuel, Design criteria, Planning, Water quality, Standards, Municipal wastewater, *Denver, Colorado.

Energy minimization efforts undertaken by the Metro Denver Sewage District are described. One of the major accomplishments lies in the secondary treatment process, where the original 370 million liters per day diffused air system was supplemented with a 272 million liters per day high purity oxygen system secondary treatment complex. The high oxygen transfer efficiency and lower total electrical power requirements have resulted in substantial savings. In the operation of the two secondary treatment complexes, flow has been sent to the high purity oxygen system at a rate such that it will be operated at capacity. The energy savings realized from close control over flow proportioning to the two secondary treatment complexes are considerable. Many cost savings as well as energy savings have also been made possible with the computer process control. Changes in operational procedures similar to the secondary treatment flow proportioning and consideration of electric motor retrofitting with capacitance equipment are methods of reducing demand. Other major successes are seen in the processing and disposal of sludge. Since 1971 sludge disposal has been in the form of land application. Anaerobic digestion of primary and waste activated sludge started in 1979 and is now part of the sludge processing line. There have also been revisions in water quality standards and treatment requirements so as to provide not only cost effective treatment but also energy effective treatment. (Baker-FRC)
W82-03142

**RETROFIT CONSERVES ENERGY AT A WATER POLLUTION CONTROL FACILITY,**
Velzy (Charles R.). Associates, Armonk, NY.
A. S. Haimes, and J. Dedyo.
AIChE Symposium Series, Vol 77, No 209, p 25-30, 1981. 2 Fig, 4 Tab.

Descriptors: *Wastewater treatment, *Phosphorus removal, Water pollution control, Activated sludge process, Lime, Microorganisms, *Energy conservation, Phosphorus, PhoStrip process.

In order to replace the existing chemical phosphorus removal process at a wastewater treatment plant in Amherst, New York, a major retrofit of process structures and incorporation of additional mechanical equipment was undertaken. Replacement was by a biological phosphorus removal process which will reduce energy use up to 81% and lime use up to 86% at thhe water pollution control facility. Such a major undertaking was an unusual step during the final stages of plant construction. The PhoStrip process will result in an operational cost savings of almost one million dollars annually. The removal of phosphorus is accomplished as follows. A portion of the phosphorus rich sludge from stage 1 clarifiers is diverted to a phosphorus stripper tank. The rest of the sludge either returns to the stage 1 oxygen transfer basins or is wasted. The sludge in the stripper tank is held in an anoxic environment, during which time the microorganisms release stored soluble phosphorus to the supernatant. The phosphorus stripped sludge is then returned to the stage 1 oxygen transfer basins. At this point, the microorganisms are returning to an aerobic environment and will take up

phosphorus in excess of that required for growth. Dilution of the influent sludge to the stripper is required to help maintain a proper sludge blanket depth and improve the stripping process. This stripper influent dilution flow is taken from the effluent of the stage 1 clarifiers. Phosphorus enriched supernatant is conveyed to the reactor clarifier, where it is limed. Reactor clarifier effluent is returned to stripper tank as an elutriation stream which is low in phosphorus concentration. (Baker-FRC)
W82-03144

**BIOLOGICAL NITROGEN REMOVAL SYSTEM DESIGN,**
Utah Univ., Salt Lake City.
H. D. Stensel.
AIChE Symposium Series, Vol 77, No 209, p 327-338, 1981. 8 Fig, 2 Tab, 15 Ref.

Descriptors: *Nitrogen removal, *Denitrification, *Respiration, *Wastewater treatment, Nitrification, Biological treatment, Design criteria, Nitrates.

Biological nitrogen removal systems which do not require an outside carbon source are discribed. Two types of nitrate reduction can occur: substrate nitrate respiration, where nitrate is reduced during the assimilation and oxidation of waste organic material (anoxic-aerobic system), and endogenous nitrate respiration, where nitrate is reduced during the respiration of the system biomass (channel flow system). There are also systems which alternate the anoxic and aerobic cells, ending with an aerobic zone. In substrate nitrate respiration the factors affecting nitrification rates are anoxic zone food to mass ratio, type of wastewater, nonbiodegradable solids present, and temperature. Endogenous respiration is affected by system mean cell residence time, specific carbonaceous oxygen uptake rate, net oxygen utilization coefficient, and net solids yield. Examples are given for design of an anoxic-aerobic system and an endogenous nitrate respiration system. (Cassar-FRC)
W82-03145

**INHIBITION OF NITRIFYING ACTIVATED SLUDGE SYSTEMS BY ORGANIC SHOCK LOADS,**
Oklahoma State Univ., Stillwater. School of Civil Engineering.
A. Esfandi, and D. F. Kincannon.
AIChE Symposium Series, Vol 77, No 209, p 339-344, 1981. 5 Fig, 1 Tab, 11 Ref.

Descriptors: *Shock loads, Nitrification, *Organic loading, *Wastewater treatment, Chemical oxygen demand, Ammonia, Pilot plants, *Activated sludge process.

The effect of organic shock loads on nitrification was investigated in a pilot plant on-stage activated sludge unit. A synthetic wastewater containing 500 mg per liter glucose and 250 mg per liter ammonium sulfate was treated at different COD and NH3 loadings: 2-, 3-, and 4- fold increases in both glucose and ammonia levels, 2-fold increase in glucose with constant ammonia concentration, and 2-fold increase in ammonia with constant glucose constant concentration. The 3- and 4-fold shock loads inhibited nitrification and caused slight increases in effluent COD. Nitrification activity recovered after 25-35 days, but effluent NH3 remained higher (60-120 mg per liter) than before the shock loads. Doubling COD, NH3, or both suppressed nitrification. NH3 levels returned to zero, except in the 2-fold NH3 shock load, where they remained slightly elevated (20 mg per liter). Effluent COD showed a slight, temporary increase in the 2-fold COD shock load experiment, but was constant in the other two 2-fold runs. (Cassar-FRC)
W82-03146

**ICI BRIXHAM - ENVIRONMENTAL RESEARCH IN THE PRIVATE SECTOR.**
Water Services, Vol 85, No 1026, p 403-405, 1981. 2 Fig, 9 Ref.

Descriptors: *Environmental protection, *Research facilities, Water treatment, Effluents, Water treatment facilities, *Wastewater treatment, Laboratories.

Brixham Laboratory is the major ICI environmental center serving the company by investigating the effects of chemical discharges in both liquid and gaseous form and in developing new ways of treating the problems and testing products for their effect on the environment. The company also has produced products helpful in treatment of different types of effluents. The Deep Shaft was originally developed as a highly efficient and space saving effluent treatment plant. The process involves the passing of raw but screened effluent through a U-shaped pipe some 120 meters long, set 60 meters into the ground. At a certain point on the down tube air is injected into the flow and the force of the effluent carries this down to the U of the pipe. As the pressure increases, the oxygen is given up from the air more easily and absorbed by the bacteria. The air also gives buoyancy to the effluent and encourages it to rise up the next part of the tube. Once at the surface, the effluent is passed through a bubble stripping device and passed to the final treatment. The company also produced Flocor plastic filtration media. Brixham Labs has been engaged in studies of site investigation for outfalls into estuarine and coastal waters, and has designed many successful plants for the treatment of effluents before discharge. Considerable effort has gone into developing analytical techniques to meet the needs of the water industry. (Baker-FRC)
W82-03153

**REMOVAL OF TOXIC HEAVY METAL IONS FROM WASTEWATERS USING MODIFIED AGRICULTURAL WASTE MATERIALS,**
Visvesvaraya Regional Coll. of Engineering. Nagpur (India). Dept. of Chemistry.
P. Kumar, and S. S. Dara.
Water Science and Technology, Vol 13, No 7, p 353-361, 1981. 2 Fig, 6 Tab, 17 Ref.

Descriptors: *Industrial wastes, *Heavy metals, *Wastewater treatment, *Food processing wastes, Industrial wastewater, Onions, Copper, Lead, Zinc, Cadmium, Farm wastes, Plant tissues, Sorption, Adsorption, Cations.

The toxic heavy metal binding capacities of agricultural byproducts such as bagasse, flour waste, paddy husk, paddy straw, onion skin and garlic skin were determined in equilibrium experiments. Onion skins were found to be the most efficient in binding heavy metal cations from solution. The onion skins were treated with sulfuric acid and formaldehyde to improve the physical characteristics of the substrate and minimize color leaching into the solution. The effect of contact time, temperature, pH and various anions on the uptake of metal ions by the modified onion skins was investigated in both equilibrium and column experiments. The residual metal ion concentration in the effluent was reduced to less than 0.1 ppm under steady state conditions using a column of the substrate. The scavenging capacity of the substrate for the cations was 1.6 meq/grams of substrate for Cu, 1.55 meq/gram for Cd, 1.35 meq/gram for Pb and 1.23 meq/gram for Zn. Methods for metal cation recovery and probable mechanisms of sorption are indicated. The implications of using modified onion skins for scavenging heavy metal ions from industrial wastes are discussed. (Geiger-FRC)
W82-03206

**BIOENGINEERING ASPECTS OF AEROBIC MICROBIAL PIGGERY WASTE TREATMENT, PART II. EFFECT OF CONTROLLED CONDITIONS ON GROWTH OF MICROFLORA AND EFFICIENCY OF BIODEGRADATION,**
Vysoka Skola Chemicko-Technologicka, Prague (Czechoslovakia).
J. Paca.
Process Biochemistry, Vol 15, No 2, p 7-10, February, 1980. 1 Tab, 8 Fig, 23 Ref.

Descriptors: *Biodegradation, *Aerobic bacteria, *Waste treatment, *Aerobic digestion, Agricultural wastes, Aerobic conditions, Aerobic treatment, Hogs, Biological treatment, Feedlot runoff, Manure, Farming, Agricultural watersheds, Microorganisms, Dilution, *Feedlot wastes.

Experiments were performed in batch and semicontinuous systems to determine the rate of biodegradation of piggery wastes. Based on these results and those obtained in a pilot plant, a plant capable of processing wastes of over 20,000 pigs was designed. Chemical analysis of fresh piggery wastes showed that this material contains high concentrations of copper salts which are added to commercial pig feed. Antibiotics are also added. These potentially toxic compounds for the metabolic activity of microorganisms decrease both the growth rate and the ability of microorganisms to degrade organic compounds. Longer times are necessary for biological treatment to overcome the chemical inhibitors. Aerobically treated wastes are preheated by vapor condensation. Volatile odor compounds are separated from the condensate, and the condensate is further treated in a multiple effect evaporator. (Titus-FRC)
W82-03212

**TYPE A ZEOLITE IN THE ACTIVATED SLUDGE PROCESS--II: HEAVY METAL REMOVAL,**
Plano-Empresa de Projectos, Lda., Lisboa (Portugal).
J. J. T. Carrondo, J. N. Lester, and R. Perry.
Journal of the Water Pollution Control Federation, Vol 53, No 3, p 344-351, March, 1981. 7 Fig, 5 Tab, 22 Ref.

Descriptors: *Heavy metals, *Activated sludge process, *Zeolites, *Wastewater treatment, Water softening, Hardness, Chemical properties.

Type A zeolite is an insoluble aluminosilicate capable of removing calcium hardness and, to a lesser extent, magnesium hardness from washing solutions and thus is used as a detergent builder. This study investigated the influence of type A zeolite on the removal of heavy metals in the activated sludge process using two pilot plants, one of which had no zeolite added to the influent wastewater. Primary settled wastewater fed to the treatment units contained nominal type A zeolite concentrations of 15 and 30 milligrams per liter, with two levels of calcium exchange for sodium in the zeolite (25 percent and 75 percent of maximum exchange capacity). The initial heavy metal concentrations in the wastewater in this hardwater area were low. No effect on heavy metal removals was noted for the metals tested at the 75 percent rate of calcium exchange, which is the normal exchange level expected to have been reached by the time the aeolite reaches a wastewater treatment plant. No effect was detected on cadmium, chromium, nickel, or lead removals in activated sludge at the lower rate of calcium exchange, which represents the level of exchange expected to have occurred after a washing program. Small but significant differences were noted for copper and zinc removals during two of the sampling periods, indicating a slight improvement in copper removal in the presence of zeolite. The removal of iron appeared to be unaffected by the presence of zeolite. No adverse effects were detected in the removal of heavy metals in the activated sludge process at either the normal or the high concentrations expected to occur in wastewaters when zeolite is used in detergents. (Carroll-FRC)
W82-03222

**THE ACTIVATED SLUDGE PROCESS--3. SINGLE SLUDGE DENITRIFICATION,**
Cape Town Univ. (South Africa). Dept. of Civil Engineering.
A. C. Van Haandel, G. A. Ekama, and G. V. R. Marais.
Water Research, Vol 15, No 10, p 1135-1152, October, 1981. 11 Fig, 1 Tab, 22 Ref.

Descriptors: *Activated sludge process, *Denitrification, Model studies, Mathematical studies, Nitrification, *Wastewater treatment, Wastewater facilities.

It is demonstrated that in the single sludge nitrification-denitrification process when the organisms are in the anoxic phase it is necessary to change the value of only one of the kinetic constants in order to model the nitrification-denitrification single

sludge system in terms of the bi-substrate active-site death-regeneration model of Dold. This change allows the Dold model to be extended so as to simulate very closely the response of the multi-reactor nitrification-denitrification process configurations under both constant and cyclic flow and load conditions. The denitrification response predicted under constant flow and load conditions can be reduced to that approximated by a zero order reaction with two rates in the primary and one in the secondary anoxic reactor respectively. The fundamental kinetic constants in the expressions for substrate utilization and nitrification are affected by the wastewater characteristics. The variability of the constants for nitrification is greater than that for substrate utilization. A single reactor system operated under sequential anoxic and aerobic periods constitutes a convenient experimental setup for determining the values of the kinetic constants of nitrification and substrate utilization and of denitrification in the anoxic phases. (Baker-FRC)
W82-03223

**DEMONSTRATION OF ANAEROBIC BIOGAS DIGESTERS IN DEVELOPING COUNTRIES. PART III: THE PHILIPPINES,**
Philippines Univ., Manila. Inst. of Public Health.
M. H. Simpson, and E. C. Morales.
Journal of Environmental Sciences, Vol 23, No 2, p 20-24, March, 1980. 8 Tab, 4 Fig, 6 Ref.

Descriptors: *Anaerobic digestion, *Biodegradation, *Biological treatment, *Wastewater treatment, *Energy sources, Technology, Anaerobic conditions, Dissolved oxygen, Waste management, Gasification, Farm wastes, Agricultural engineering, Manure, Agriculture, Sludge, *Philippines.

Waste management in the Phillippines also provides an energy source. Biogas plants, which have been widely established since 1977, turn waste products into energy sources. Effluent water is used for production of algae for livestock and poultry feed as well as production of fish and fertilizing-irrigating of pasture and vegetable plots. Because the Philippines is an agricultural country, there are large supplies of locally available raw materials for biogas production. The use of biogas digesters in sewage disposal systems in housing developments is now under consideration. However, the efficiency of biogas production from human waste is relatively low. (Titus-FRC)
W82-03226

**THE TERTIARY TREATMENT OF SEWAGES. CONCLUSION,**
Loughborough Univ. of Technology (England).
K. V. Ellis.
Effluent and Water Treatment Journal, Vol 20, No 11, p 527-529, 531-533, 535, 537, November, 1980. 1 Tab, 41 Ref.

Descriptors: *Sewage treatment, *Tertiary treatment, Filtration, Flotation, Reviews, *Great Britain.

The tertiary treatment of sewages is reviewed. Specific attention is given to the moving bed filter, microstrainers, maturation ponds, and other tertiary treatment methods, including nitrifying filters. Use of the moving-bed filter eliminates the necessity of periodically removing the filter from operation in order to clean it. Microstrainers are hollow cylinders, with the cylindrical surfaces covered with a fine stainless steel fabric. In general a microstrainer can be expected to remove between 50 and 60% of the suspended solids from a secondary effluent together with somewhat over 30% of the remaining BOD. Microstrainers have been used in the treatment of industrial wastewaters and to strain storm waters. Maturation ponds are widely used as the third stage in the progression through the stabilization pond process. The principal disadvantages are the area of land required and the possibility of discharging an effluent with a high algae content. Dissolved-air flotation can deal with periodic excessive loss of solids from secondary settlement tanks. (Baker-FRC)
W82-03228

**SAND-FILTER TRENCHES FOR PURIFICATION OF SEPTIC TANK EFFLUENT: I. CLOGGING MECHANISM AND SOIL PHYSICAL ENVIRONMENT,**
Norges Landbrukshoegskole, Vollebekk. Dept. of Microbiology.
R. Kristiansen.
Journal of Environmental Quality, Vol 10, No 3, p 353-357, July-September, 1981. 5 Fig, 2 Tab, 31 Ref.

Descriptors: *Sand filters, *Wastewater treatment, *Clogging, Filters, Sand, Physical properties, Soil physical properties, Soil chemistry, Ponding, Temperature effects, Soil water, Carbon, Nitrogen, Oxidation-reduction potential, *Septic wastewater, *Norway.

The Norwegian manual of septic tank practice prescribes a 20-meter artificial sand-filter trench per family-house for areas in which the soil is not suitable for direct disposal of septic tank effluent. Although the phenomenon of clogging in such disposal systems has been studied, the effects of clogging on purification efficiency have not been stressed. The relationship between clogging and soil physical and chemical environment in sand filter trenches was investigated over a 17-month period. Trenches were loaded with septic tank effluent at a rate of 4 to 6 cm/day (A and C) or 12 to 18 cm/day (B). Ambient temperatures of 4 to 16 C were maintained in trenches B and C, while the temperature in A was 12 to 15 C. Sand surface clogging and ponding occurred in the end of the filters where septic tank effluent concentrated. Ponding rates and crust resistances were highest for trench A, at 0.33 square meters per month and 35 days, respectively, and lowest for trench C, at 0.16 square meters per month and 4 days, respectively. The carbon/nitrogen ratio in the crust zone was similar to that in the rest of the sandfill. About 0.74 percent of the pore volume in the clogged layer of trench A was occupied by bacterial cells. Production of extracellular slimy material was probably dependent on temperature. Soil water content below the crust zone decreased with increasing clogging intensity. The increased clogging led to improved aeration, as shown by gas and redox measurements. Low redox potential values of less than 0 mV and oxygen contents below 2 percent were found mostly in the crusted zone of unit A, although they were also regularly found down to 30 centimeters in the clogged end of unit C. Nitrogen contents of up to 93 percent were found in sand filter zones containing less than 1 percent oxygen. N20 contents above the detection limit of 200 parts per million were not found in any of the filters. (Carroll-FRC)
W82-03238

**SAND-FILTER TRENCHES FOR PURIFICATION OF SEPTIC TANK EFFLUENT: II. THE FATE OF NITROGEN,**
Norway Agricultural Research Council, Aas.
R. Kristiansen.
Journal of Environmental Quality, Vol 10, No 3, p 358-361, July-Septmeber, 1981. 2 Fig, 1 Tab, 20 Ref.

Descriptors: *Nitrogen, *Sand filters, *Wastewater treatment, Filters, Sand, Oxidation-reduction potential, Soil properties, Nitrification, Temperature effects, Clogging, Biomass, *Septic wastewater, *Norway.

It has been suggested that septic systems in some areas contribute to the nitrogen content of groundwater. Nitrogen turnover in sand-filter trenches, important factors affecting nitrogen turnover, and the potentials of these filters for nitrogen removal were investigated as part of a 17-month study of sand-filter trenches. Trenches were loaded with septic tank effluent at a rate of 4 to 6 centimeters per day (A and C) or 12 to 18 centimeters per day (B). Ambient temperatures of 4 to 16 C were maintained in trenches B and C, while the temperature in A was 12 to 15 C. This study found that only insignificant amounts of nitrogen were removed from the effluent passing through the filters. During the cold seasons nitrification was significantly affected by the sand temperature. In trenches B and C, which had the lowest clogging intensities, nitrate was mostly found near the bottom air vent, while in A, which had the highest clogging intensity, nitrification occurred between 7.5 and 27 centimeters below the crust. Nitrogen bound in the microbial biomass, absorbed to the cation exchange complex, and bound in dead organic material could amount to about 3 months of nitrogen loading from a single-family home to a standard 20-meter sand filter trench. This nitrogen is only temporarily removed and will be subsequently nitrified and leached out. It appears that denitrification does not occur in continuously loaded sand filters. Potential means of improving denitrification in septic systems include intermittent loading or recycling of nitrified effluent. (Carrol-FRC)
W82-03239

**DULUTH SANITARY DISTRICT FIRST IN U.S. TO TAKE CHARGE OF BOTH SEWAGE AND REFUSE.**
For primary bibliographic entry see Field 5E.
W82-03249

**MUNICIPAL WASTEWATER TREATMENT PLANT PIONEERS IN CONSERVATION APPROACH,**
Pirnie (Malcolm) Inc., White Plains, NY.
R. F. Bonner, Jr.
Civil Engineering (New York), Vol 50, No 7, p 57-59, July, 1980. 3 Fig.

Descriptors: *Energy conservation, *Waste heat, Heat budget, Wastewater treatment facilities, Skimming, Fuel oil, Design criteria.

Energy conservation equipment has been incorporated into the expansion designs for the Southerly Wastewater Treatment Plant in the Northeast Regional Sewer District, Cleveland. Although the conservation technology used at this plant is not new, it is believed that this is the first municipal treatment plant to use this combination of features. Designs include 10 treated effluent water-to-water heat pumps and 6 exhaust air energy wheels to provide heat for 13 buildings, saving 450,000 gal of fuel oil annually. The skimmings recovery is expected to save 2.75 million gal of oil annually, and the waste heat recovery system, 1.18 million gal. (Cassar-FRC)
W82-03255

**IMPROVED PERFORMANCE IN COMBINED NITRIFICATION/DENITRIFICATION OF TANNERY WASTE,**
Science and Education Administration, Philadelphia, PA. Eastern Regional Research Center.
C. C. Panzer, M. Komanowsky, and G. E. Senske.
Journal of the Water Pollution Control Federation, Vol 53, No 9, p 1434-1439, September, 1981. 4 Fig, 3 Tab, 13 Ref.

Descriptors: *Tannery wastes, *Nitrification, *Denitrification, *Nitrogen removal, Industrial wastewater, Wastewater treatment, Biological treatment, Nitrates.

Over of 97% total Kjeldahl nitrogen (TKN) and 93% of soluble COD were removed from a lime sulfide unhairing effluent, which had been physically and chemically pretreated, in a laboratory scale combined nitrification/denitrification process. In six test runs, influent TKNs were 171-240 mg per liter; influent COD, 1039-1649 mg per liter. In the process the waste is nitrified in the aerobic zone and then returned to the anoxic zone for denitrification. The higher the rate at which the aeronic mixed liquor is returned to the anoxic zone, the greater the degree of nitrate removal, which in these runs ranged from 0.13 - 0.17 mg N per mg per day. A high influent COD produced better nitrate removal. The high rate and degree of nitrate removal in the first stage was enhanced in the laboratory system by limiting the rate of aeration in the last aerobic stage and sparging the anoxic zone with nitrogen gas. Although this would not be practical on a commercial scale, several possible alternatives are suggested. (Cassar-FRC)
W82-03277

**MUNICIPAL SEWAGE: THREE COMMUNITIES TRY TO COPE,**
A. Morrison.
Civil Engineering (New York), Vol 50, No 9, p 90-94, September, 1980. 3 Fig.

Descriptors: *Municipal wastewater, *Wastewater facilities, *Combined sewers, Milwaukee, Wisconsin, San Francisco, California, Winnipesaukee River, New Hampshire, Wastewater treatment, Sewer systems, Overflow, Legal aspects, Judicial decisions, Wastewater disposal, Effluent standards, Water pollution prevention, Water quality control, Cost-benefit analysis.

The City of Milwaukee is appealing to the Supreme Court for relief from the stringent anti-pollution requirements imposed by the Federal District Court. The decision ordered the city to upgrade its treatment system to the tertiary level and abate all combined sewer overflows by 1989, with all other overflows abated by 1986. The $1.6 billion master plan, which the city hopes will not have to be fully implemented, includes a collection, storage, and treatment plan to handle combined and separate sewer overflows. In addition to rehabilitating existing sewers and treatment plant, the plan calls for 460 miles of new storm sewers, 2 miles of new sanitary sewers, storage facilities, 2 major interceptor sewers, smaller interceptor and relief sewers, and a storage cavern built under the municipal stadium. San Francisco is working on a $2.3 billion three-stage plan for treatment and combination of primary and secondary effluents to discharge into the ocean. New Hampshire's Winnipesaukee River Basin project ($65 million) is designed to improve lakes for tourist and recreation purposes. At the project's completion in 1982, all secondary effluent will be discharged into the Merrimac River rather than into lakes where algal blooms have been troublesome. (Cassar-FRC)
W82-03284

**EFFICIENCIES OF ADVANCED WASTE TREATMENT OBTAINED WITH UPGRADED TRICKLING FILTERS,**
Brown and Caldwell, Eugene, OR.
D. P. Norris, D. S. Parker, M. L. Daniels, and E. L. Owens.
Civil Engineering (New York), Vol 50, No 9, p 96-101, September, 1980. 5 Fig, 3 Tab, 2 Ref.

Descriptors: *Trickling filters, *Solids contact processes, *Advanced wastewater treatment, Wastewater treatment, Corvallis, Oregon, Effluents, Biological oxygen demand, Suspended solids, Sludge, Clarification.

The trickling filter process, combined with solids contact clarification, can consistently produce an effluent quality meeting EPA's definition of secondary treatment. In plant-scale tests at Corvallis, Oregon, BOD5 and suspended solids of less than 10 mg per liter were obtained at filter loadings of 30 lb BOD5 per 1000 cu ft per day or less and 15 mg per liter at 40 lb BOD5 per 1000 cu ft per day. The waste secondary sludge is exceptionally dense and can be wasted directly to primary sedimentation, eliminating thickening. Optimum mixed liquor solids concentration is 1500 mg per liter. This low-cost, trouble-free, low-energy process may enable many existing trickling filter plants to upgrade their efficiency to meet today's standards with minimum capital outlay. (Cassar-FRC)
W82-03285

**ARTIFICIAL PARTICULATE FOULING OF HYPERFILTRATION MEMBRANES IV. DYNAMIC PROTECTION FROM FOULING,**
Rensselaer Polytechnic Inst. Dept. of Chemical and Environmental Engineering.
For primary bibliographic entry see Field 3A.
W82-03288

**WATER COST ENCOURAGES REUSE AND CONSERVATION,**
Pirnie (Malcolm) Inc., White Plains, NY.
G. P. Westerhoff.
Consulting Engineer (St. Joseph), Vol 57, No 3, p 87-90, September, 1981. 1 Fig.

Descriptors: *Water reuse, *Reclaimed water, *Water costs, Water management, Water conservation, Wastewater reuse, Water supply, Water shortage, Cooling water, Irrigation water, Steel industry, Prices, Industrial water, Legislation.

Water reuse is practiced extensively in the U.S. and other countries and can be expected to receive more attention as water supply problems and higher water prices occur. Water is directly reused in irrigation, recreation, groundwater recharge, and industry. Reclaimed wastewater is used in treatment plants for addition to potable supplies and for cooling water. Current industrial reusers are steel manufacturers, refineries, power plants, and chemical manufacturers. Water reuse projects are often difficult to implement because so many government agencies are involved. Computer models are helpful in formulating regional plans, which are more effective than local plans. Dual or plural water quality schemes offer economic advantages and stretch the supply. Water prices should more closely reflect actual costs of treatment, storage, and transmission to encourage reclamation and conservation. The Office of Water Recycling, created in 1977, sponsors research and development on major industrial reuse applications. However, funds for this office are expected to be reduced in future budgets. (Cassar-FRC)
W82-03295

**GAO FINDS MASSIVE FAILURE OF WASTEWATER TREATMENT PLANTS,**
A. Morrison.
Civil Engineering (New York), Vol 51, No 4, p 74-76, April, 1981. 1 Tab.

Descriptors: *Effluents, *Discharge(Water), *Water pollution, *Design, *Wastewater treatment facilities, Wastewater treatment, Legislation, Regulations, Governments, Engineering.

A recent report from the General Accounting Office of Congress states that more than half of America's municipal waste water treatment plants are not functioning according to design. Effluents from 242 randomly selected plants were monitored. Between 1978 and 1979, 87% of these plants violated their discharge permits, 31% seriously. There are many reasons for plant failure: inferior equipment substituted under the federal procurement regulations 'or equal' clause, inadequately trained operations personnel, infiltration/inflow, and design failures. Accountability for these failures is difficult to fix, and the EPA has been reluctant to encourage legal action for several reasons. The final result is that Federal and State governments spend millions of dollars to bring treatment plants up to standard. (Cassar-FRC)
W82-03299

**USE OF ADENOSINE TRIPHOSPHATE IN BIOLOGICAL PURIFICATION SYSTEMS (IN FRENCH),**
Rennes Ecole Nationale Superieure de Chimie (France).
G. Martin, S. H. Nam, O. Vitrac, and M. Reinbold.
Water Research, Vol 14, No 4, p 379-387, April, 1980. 8 Fig, 1 Tab, 27 Ref.

Descriptors: *Wastewater treatment, *Adenosine triphosphate, *Activated sludge, Activated sludge process, Suspended solids, Biological wastewater treatment, Biomass, Organic loading.

The variation in adenosine triphosphate (ATP) of an activated, aerobic non-nitrifying sludge was determined as a function of the bulk loading under constant conditions. The study was intended to resolve the difficulty caused by different biological activity of microorganisms and the inactive particles included in determining biomass in purification units. Under steady state conditions the ATP content per unit of volatile suspended substances (VSS) of the sludges is a function of the bulk loading. The ATP amount is connected to the rate of active biomass, and is an indicator of the elimination of organic pollution. With organic supplementation the ATP level is relatively constant, but otherwise the variation is significant. A system functioning with a bulk loading of 0.5 based on COD can tolerate an organic or hydraulic overload of at least three-fold for a short time without difficulty. The ATP/VSS ratio was determined under a constant bulk loading and at a charge which varied from 0.44 to 9.4 kg COD/day/kg VSS. Measurements of ATP can be used to predict effects of biological accidents at a station, e.g., aeration interruption, a sudden load variation, or accidental arrival of contaminants. (Hertzoff-FRC)
W82-03302

**DIRECT INFLUENCE OF WASTEWATER POLLUTANTS ON FLOCCULATION AND SEDIMENTATION BEHAVIOR IN BIOLOGICAL WASTEWATER TREATMENT-I. MODEL SYSTEM E. COLI B,**
Swedish Inst. for Surface Chemistry, Stockholm.
L. Eriksson, and C. Axberg.
Water Research, Vol 15, No 4, p 421-431, April, 1981. 15 Fig, 2 Tab, 50 Ref.

Descriptors: *Sedimentation, *Escherichia coli, *Activated sludge, Flocculation, *Wastewater treatment, Colloids, Coagulation, Model studies, Pollutants, Biological treatment, Metabolism.

To obtain a high quality effluent when using the activated sludge process of waste water treatment, effective sedimentation is required. the rate of sedimentation depends upon the composition of pollutants in the waste water, the composition of the microbial flora, and the operational parameters of the treatment system. The metabolic activities, surface properties of the cells, and their release of polymeric materials should also be considered. A study was conducted on the effects of selected pollutants in waste water on the flocculation process to clarify the colloid chemical processes using the model system, Escherichia coli B. The amount of extracellular polymeric material present in the system affected the coagulation by neutral salts and the degree of influence of the model pollutants tested. For several of the pollutants tested, marked effects on sedimentation were noted when the cells were undergoing slow coagulation close to the critical coagulation concentration. These findings were attributed to the interactions between extracellular polymers and pollutants affecting the cellular bridging. (Geiger-FRC)
W82-03319

**INDUSTRIAL WASTEWATER AUDIT,**
Donohue and Associates, Inc., Sheboygan, WI.
M. L. Crosser, and J. Turk.
Industrial Wastes, Vol 26, No 3, p 22-24, 36, May/June, 1980. 1 Fig, 1 Tab, 9 Ref.

Descriptors: *Industrial wastes, *Steel industry, *Wastewater treatment, Aerated lagoons, Lagoons, Suspended solids, Heavy metals, Phosphorus, Evaluation, Wastewater analysis.

An industrial wastewater audit is an organized determination of the source, quantity, composition and chemistry of each wastewater stream at an industrial facility. The purpose of the audit is to develop the data base required to decide which combination of actions, including process changes, process water recycling and final treatment, will provide compliance with discharge standards at minimum cost and with minimum disruption of production. The requirements for such an audit and a case history of an audit are presented. The example cited is a stainless steel products manufacturing company. Five major steps compose an audit: understanding the processes and staff relationships, planning the flow monitoring sampling and analysis program, conducting the actual program, evaluating the data obtained, and writing the report. Wastewater treatment at this particular audit site was provided by an aerated lagoon, and waste loads were reduced by installing an evaporator to concentrate electropolishing rinsewater for chemical recovery. The audit results suggested that a program be devised to repair the plumbing, reduce process water usage, and divert clean water from the process wastewater sewer, resulting in a reduction of process wastewater from 80,000 to about 55,000 Gpd. An alternative to the phosphorus-containing alkali cleaning compound was selected. Methods for dealing with heavy metals

were reevaluated. A method to capture overflow from the alkaline washers was placed under study. (Baker-FRC)
W82-03337

**OPERATION REPORTS--CITY OF PUEBLO, COLORADO DEPARTMENT OF PUBLIC WORKS.**
Journal of the Water Pollution Control Federation, Vol 53, No 6, p 1149-1150, June, 1981. 4 Tab.

Descriptors: *Operating costs, *Wastewater treatment, *Pueblo, *Colorado, Anaerobic digestion, Municipal wastewater, Energy conservation, Methane, Sludge disposal, Stormwater.

The City of Pueblo, Colorado, treated 18.47 million cu meters (4.88 billion gallons) of wastewater at an average daily rate of 50,400 cu meters during 1980. An average of 2500 cu meters of methane was produced daily in the anaerobic digestion process. Effluent contained an average 21.8 mg per liter suspended solids, 32.5 mg per liter BOD, 6.74 mg per liter dissolved oxygen, 7.6 pH, 18.3 mg per liter ammonia, and 301.4 per 100 ml fecal coliforms. Cost per million gallons treated was $118. (Cassar-FRC)
W82-03348

**WASTEWATER TREATMENT: CORROSION SOLUTION ARE AS VARIED AS PROBLEMS,**
Engineering Science, Inc., Atlanta, GA.
For primary bibliographic entry see Field 8G.
W82-03350

**ENGINEERS ASSESS AQUACULTURE SYSTEMS FOR WASTEWATER TREATMENT,**
Cold Regions Research and Engineering Lab., Hanover, NH.
S. C. Reed, R. K. Bastian, and W. J. Jewell.
Civil Engineering (New York), Vol 51, No 7, p 64-67, July, 1981. 4 Fig.

Descriptors: *Aquaculture, *Wastewater treatment, Water treatment facilities, Water hyacinth, Duckweed, Wetlands.

An overview of wetland processes and aquatic plant systems is presented. Wetlands are defined as land where the water table is at or above the surface of the land long enough each year to maintain saturated soil conditions and growth of related vegetation. At present, wetland systems are generally limited to further treatment of secondary effluents. In a few cases primary effluent has been applied in constructed systems. Bacteria attached to plant stems and humic deposits are assumed to be the major factor for biological oxygen demand and nitrogen removal when plant harvesting is not practiced. Plant production plays a more significant role in nutrient removal when harvesting is included. For natural wetlands, major costs and energy requirements involved are significantly lower than if a wetland is constructed. One drawback of natural wetlands is that it is more difficult to control the process because of natural variability within the system. Health risks for wetland systems are probably not higher than for conventional treatments, assuming that insect vectors are controlled and harvested materials are not used for direct human consumption. Information on systems that use free floating aquatic plants for treating wastewater is limited to the use of either water hyacinths or duckweeds. Such systems are generally similar in concept to wastewater treatment-pond technology. Water hyacinth systems are able to remove high levels of BOD, suspended solids, metals and nitrogen, plus significant removal of refractory trace organics. The root systems support a very active mass of organisms that assist in treatment. (Baker-FRC)
W82-03354

**THE FATE OF ORGANIC MICROPOLLUTANTS THROUGH AN INTEGRATED WASTEWATER TREATMENT WATER RECLAMATION SYSTEM,**
National Inst. for Water Research, Pretoria (South Africa).
J. F. J. Van Rensburg, A. Hassett, S. Theron, and S. G. Wiechers.
Water Science and Technology, Vol 13, No 1, p 537-552, 1981. 3 Fig, 7 Tab, 20 Ref.

Descriptors: *Organic compounds, *Water reclamation, *Fate of pollutants, Wastewater treatment, Water treatment, Trihalomethanes, Pesticides, Insecticides, Trace levels, Polynuclear aromatic hydrocarbons, Phenols, Chlorinated hydrocarbons, Activated carbon, Adsorption, *South Africa.

An integrated wastewater treatment/water reclamation system (a modified lime flotation biological pilot plant), produced a final water superior in quality to water supplies in three South African cities as well as to the final effluent from a non-integrated system. Potentially hazardous organic micropollutants were added to the feedwater at concentrations of 40 micrograms per cu dm for each compound. Effluents from each process step were analyzed to monitor the removal. The final effluent contained 0.8 micrograms per cu dm dibutyl phthalate (probably from the plastic pipe used in the pilot plant) and 2.6 micrograms per cu dm of total volatile halogenated hydrocarbons. Each step in the treatment process removed a percentage of the organic pollutants from the effluent of the preceding step as follows: dentrification, 37%; chemical clarification, 35%; nitrification pond and biological clarifier, 69%; prechlorination, 21%; roughing filter and dual media filter, 34%; activated carbon adsorption, 89%. Certain materials were removed selectively in certain steps of the process. Denitrification and chemical clarification removed a large percentage of most compounds. The biological clarifier reduced remaining naphthalene, dichlorvos, anthracene, m-cresol, chlorophenol, and beta-naphthol to nondetectable concentrations. Prechlorination removed the residual trichlorophenol; and filtration, the residual acenaphthene and hexadecane. Activated carbon served as a safety barrier to remove final traces of other organic compounds. Shock loads of 40 micrograms per cu dm of each of the 19 compounds for 30 hours resulted in complete removal of these compounds with no apparent ill effects on the plant. (Cassar-FRC)
W82-03364

**THE DEEP-SHAFT PROCESS: BRIGHT FUTURE FOR TREATING HIGH-STRENGTH WASTEWATERS.**
Civil Engineering (New York), Vol 51, No 5, p 74-76, May, 1981. 1 Fig.

Descriptors: *Wastewater treatment, Deep-shaft process, *Economic aspects, Primary treatment, Secondary treatment, Bacteria, Industrial wastes, Municipal wastes.

A new wastewater treatment process is described which makes use of a deep shaft, a process promising to cut land use 10-30% and power cost as well. Raw wastewater is injected into this deep shaft, where the high water pressure forces air bubbles into solution. The method is being tried at a New York wastewater treatment plant. In these underground aeration tanks air is added to the wastewater and bacteria break down the wastes. In the deep shaft process primary treatment is usually eliminated. Raw sewage is injected directly into the deep shaft, 40% of the way down, or at a depth of 200 feet. The wastewater travels down the inside of the downcomer pipe to the bottom of the shaft and then up through the annual space between pipe and shaft walls. The wastewater is moved round and round inside the shaft by compressed air bubbles injected about 40% of the way down the shaft. An individual slug of wastewater makes several cycles before being drawn off to the surface for clarification. Virtually all of the air that is injected into the wastewater column goes into solution, as dissolved oxygen, dissolved nitrogen, and other gases. Chief advantages are space saved, lack of need for primary treatment, production of a floated sludge that is much higher in solids concentrations than the sludge that settles out in a gravity clarifier, and apparent quick recovery from shock loadings. (Baker-FRC)
W82-03376

**SEPTIC SEWAGE SYSTEMS CONTAMINATE GROUND WATER.**
For primary bibliographic entry see Field 5B.
W82-03378

**ANAEROBIC SLUDGE DIGESTION--NEED IT BE EXPENSIVE,**
Severn Trent Water Authority (England).
C. E. Brade, and G. P. Noone.
Effluent and Water Treatment Journal, Vol 21, No 9, p 391-393, 395-397, 399-401, 403-406, September, 1981. 6 Fig, 5 Tab, 52 Ref.

Descriptors: *Sludge digestion, *Cost analysis, *Anaerobic digestion, Biodegradation, Digestion, Sludge, Anaerobic conditions, Biological treatment, *Wastewater treatment, Severn-Trent Waterway, United Kingdom.

Recent work carried out within the Severn-Trent Water Authority with the aim of improving and extending treatment processes while minimizing the resultant capital and revenue requirements is reported. The work resulted in several conclusions. It appeared that in the case of anaerobic digestion, failure to operate at maximum process efficiency was not due to biological overload, but rather to an inability within current operation to exploit the activities of the microorganisms. The approaches have been to uprate the processing input so that the biological process becomes rate limiting, rather than the physical factors of mixing, temperatures or seeding. Full scale plant investigations demonstrated that great scope exists to reduce the cost of anaerobic digestion by several methods. The first method calls for uprating the existing digestion plant, principally by improved mixing and heating, where examination shows the plant to be inadequate. Another method indicates that small to medium sized digestion centers can be cheaply acquired by changing the use of various available tanks, especially in semi-rural works. Finally, new green-field digestion plants should have much lower volumetric provisions, with more emphasis placed on process equipment and higher levels of standby equipment than is currently provided. Digestion improvement is not restricted to the primary reactor. Attention should also be given to the increase of input solids level and subsequent consolidation. One requirement for a more efficient process is closer plant control, involving more process analyses. (Baker-FRC)
W82-03389

**CONTINUOUS ION EXCHANGE: A SURVEY OF RECENT APPLICATIONS,**
M. J. Slater.
Effluent and Water Treatment Journal, Vol 21, No 9, p 416-418, 420-422, September, 1981. 8 Fig, 16 Ref.

Descriptors: *Ion exchange, *Wastewater treatment, Resins, Water treatment, Industrial wastes, Radioactive wastes, Design criteria, Wastewater facilities.

This article surveys the main types of apparatus and their important design features for continuous ion exchange systems. The major industrial types of moving packed bed and fluidized bed plants are described. While various industrial applications of moving packed bed plants have been planned, the impact on the water treatment industry is not marked. The chemical efficiency of fixed bed plants can be made to approach that of continuous plants by using counter-flow regeneration or the merry-go-round principle. Continous plants need to be made cheaper so that they can be used on a smaller scale, and the reliability, although high, perhaps needs to be demonstrated more clearly and improved further. Fluidized bed plants have a part to play in treating dirty waste streams or ore leach solutions and have become accepted, but further simplification is desired to make recovery of low value solutes economically worthwhile. (Baker-FRC)
W82-03391

**KINETICS OF PHENOL OXIDATION BY WASHED CELLS,**

University Coll. of Swansea (Wales). Dept. of Chemical Engineering.
W. Sokol, and J. A. Howell.
Biotechnology and Bioengineering, Vol 23, No 9, 2 fig, 6 Tab, 13 Ref.

Descriptors: *Phenol, *Oxidation, *Bacteria, Pseudomonas putida, *Fate of pollutants, *Wastewater treatment, Model studies, Microorganisms, Fermentation, Kinetics, Monod-Haldane equation.

A model was developed to predict the uptake of phenol by organisms growing in continuous culture on phenol in the high conversion range. Uptake rates of Pseudomonas putida per unit biomass per unit time were determined at phenol concentrations of 5 to 1000 mg per liter at intervals of 2.7 to 8 hours. The best fitting model was a 2-parameter simplification of the Monod-Haldane model. One parameter remained fairly constant with changes in growth conditions, while the other increased monotonically with phenol concentrations in the chemostat. The apparent threshold for induction was 0.1 mg per liter phenol. (Cassar-FRC)
W82-03399

## 5E. Ultimate Disposal Of Wastes

**SLUDGE MANAGEMENT PROCESS INTEGRATION,**
Cornell Univ., Ithaca, NY.
For primary bibliographic entry see Field 5D.
W82-03130

**OZONE FOR THE TREATMENT OF HAZARDOUS MATERIALS,**
Jacobs Engineering Group, Washington, DC.
For primary bibliographic entry see Field 5D.
W82-03139

**DULUTH SANITARY DISTRICT FIRST IN U.S. TO TAKE CHARGE OF BOTH SEWAGE AND REFUSE.**
Civil Engineering (New York), Vol 50, No 6, p 60-63, June, 1980. 2 Fig.

Descriptors: *Fluidized bed process, *Incineration, *Solid wastes, Wastewater treatment facilities, *Diluth, Minnesota, Activated sludge process, *Waste disposal, Advanced wastewater treatment, Oxygenation, Water quality, Wastewater disposal.

The Western Lake Superior Sanitary District, serving Duluth, Minnesota, is the first sanitary district in the U.S. to handle disposal of both wastewater and municipal refuse. A pure oxygen activated sludge process is used. Since the 45 mgd central advanced wastewater treatment plant went on stream in 1978, the water quality in the St. Louis River and St. Louis Bay has improved dramatically. Effluent from the plant has 10-12 mg per liter BOD and 10-12 mg per liter suspended solids, a higher quality than the state requires. Refuse is chopped to a final size of 1.5 in. and is air-separated into light and heavy fractions. The light, combustible fraction is coincinerated with sludge in a fluidized bed reactor, saving over $3 million in fuel costs alone. (Cassar-FRC)
W82-03249

**GROUNDWATER CONTAMINATION BY CHLORINATED HYDROCARBONS: CAUSES AND PREVENTION,**
Environmental Protection Agency, Philadelphia, PA.
H. G. Byer, W. Blankenship, and R. Allen.
Civil Engineering (New York), Vol 51, No 3, p 54-55, March, 1981. 3 Fig, 1 Tab.

Descriptors: *Chlorinated hydrocarbons, *Industrial wastes, *Water pollution control, Nitroglycerine trap, *Waste disposal, Ultimate disposal, Organic compounds, Aquifers, Path of pollutants, Soil contamination, Disposal, Waste storage, Landfills.

Chlorinated hydrocarbons, such as trichloroethylene, chloroform, and tetrachloroethane, have wide use in the U. S. in industry and in the home as solvents, degreasers, cleaning agents, etc. Waste treatment and disposal of these organic compounds, 4.6 million tons of which were produced in 1978, is difficult because of their high density and limited solubility in water. Unlike lighter oils, these dense compounds sink to the bottom of a stream, lake, pond, or landfill, thus becoming readily available for penetration into the underground aquifer. To prevent such contamination, industrial work places should have concrete floors, sloped to direct spills, and a 'nitroglycerine trap' to prevent material from escaping into sewers, streams, and the ground surface. Any wastewater holding pond or lagoon should be lined with impervious material to prevent groundwater contamination. Improper disposal or spills of chlorinated hydrocarbons may violate the Safe Drinking Water Act, the Toxic Substance and Control Act, the Solid Waste Management Act, the Resource Conservation and Recovery Act, and the Clean Water Act Amendment. (Cassar-FRC)
W82-03300

**MODERN MANAGEMENT TECHNIQUES, PART II A: CASE HISTORY OF PRODUCTION IMPROVEMENT,**
LWFW, Inc., Dallas, TX.
For primary bibliographic entry see Field 6A.
W82-03310

**COMPLETION OF THE LIST OF ANALYTICAL SOLUTIONS FOR NUTRIENT TRANSPORT TO ROOTS 1. EXACT LINEAR MODELS,**
Purdue Univ., Lafayette, IN. Dept. of Agronomy.
J. H. Cushman.
Water Resources Research, Vol 16, No 5, p 891-896, October, 1980. 4 Fig, 27 Ref.

Descriptors: *Model studies, *Soil-water-plant relationships, *Nutrient transport, *Root systems, Nutrients, Mathematical models, Ultimate disposal, Disposal, Waste disposal, Solutes.

Solutions to a linear transport model for nutrient or waste flow to roots are presented in connection with solid and liquid waste storage in the ground and protection of water supplies. A root is imagined as a cylinder with large length compared to its radius and is studied individually. The solutions include no interroot competition and various types of interroot competition. They extend to nutrient flow at high and low concentrations. A subsequent paper will examine the sensitivity of these solutions to various parameters. (Cassar-FRC)
W82-03327

**NOTE ON DESIGN OF DIFFUSERS FOR SEWAGE OUTFALLS BASED ON THE WORK OF RAWN ET AL.,**
Waterloo Univ. (Ontario). Dept. of Man-Environment Studies.
E. J. Farkas.
Journal of Environmental Science and Health, Part A, Environmental Science and Engineering, Vol 16, No 2, p 251-257, 1981. 2 Tab, 11 Ref.

Descriptors: *Outfall sewers, *Wastewater disposal, *Design criteria, Lakes, Lake Ontario, Effluents, Sewage, Water currents.

A specific case is reviewed in which the design of a diffuser for a sewage outfall was based on the work of Rawn et al., in the hopes that future designers may benefit from certain questionable aspects of this design. The diffuser and sewer outfall in question were designed in 1974 and 1975. The outfall was intended to serve a new sewage treatment plant which was to accept sewage from a large area east and north of Toronto, Canada. The outfall takes sewage treatment plant effluent out into Lake Ontario via a 1000 meter tunnel bored in rock on the bed of Lake Ontario. Diffuser ports are arranged along the outer 150 meters of the tunnel. Vertical borings were made at even spacings along the tunnel, and the sewage effluent is released horizontally at the floor of the lake via nozzles, more than 6 meters below the lake surface. The first question which arises concerns the adaptability of the work of Rawn to fresh water, since the original work was designed for sea water. Another question pertains to the presence or absence of currents in the receiving water body. A very large margin of safety must be incorporated for cases in which there is any period of low- or no-current conditions in the receiving water. (Baker-FRC)
W82-03347

**ENTRENCHMENT OF SEWAGE SLUDGE--A DISPOSAL-USE ALTERNATIVE,**
Science and Education Administration, Washington, DC.
L. J. Sifora, and D. Colacicco.
Civil Engineering (New York), Vol 50, No 4, p 80-82, April, 1980. 2 Fig, 5 Tab, 6 Ref.

Descriptors: *Trenches, *Sludge disposal, *Land application, Metals, Food chains, Microorganisms, Crop production, Environmental effects, Bacteria, Fate of pollutants, *District of Columbia area.

An alternative disposal method for sewage sludge from the Washington, D.C., metropolitan area involves placing undigested sludge in trenches. The disposal rate is 1000-1300 wet tons per acre. Little odor and no surface runoff results. A sludge volume of 200-400 wet tons per day is handled using concrete mixer trucks, trenching machines, and pumping equipment. Sludge at 22% solids content is placed in a trench about 24 inches wide and 3 ft deep, on 3.9 ft centers. An interval of 4.9 ft or more between sludge and highest groundwater level is necessary. The trenching machine immediately follows the disposal trucks, covering the filled trench with soil dug from an adjacent trench. The surface is stabilized by leveling and applying lime, fertilizer, and grass seed. Corn grown on one of these sites 1 year after entrenchment had slightly higher Zn and Cu, but metal levels were within the range of levels found in corn grown with commercial fertilizers. However, sludges and crops vary, and no general statement on metal uptake or crop yield can be made. Trench plots monitored over a 5 year period showed little metal leaching. After 3 months fecal coliforms decreased by 5 to 7 log reduction and total coliforms by 2-3 log reduction. Salmonella and indicator virus (f2) were undetectable. Total coliforms remained elevated in the soil near the sludge-soil interface for 1 year. Estimated cost for the 400 ton per day operation in Washington is $24.40 per wet ton (1978 dollars). (Cassar-FRC)
W82-03353

**COMPOSTING RESULTS IN LOS ANGELES,**
R. T. Haug, and B. Davis.
BioCycle, Vol 22, No 6, p 19-24, November-December, 1981. 9 Fig, 7 Ref.

Descriptors: *Sludge, *Composting, Land disposal, Odors, *Sludge disposal, Organoleptic properties, *Wastewater treatment, Energy conservation, Municipal wastewater, Planning, Design criteria, Incineration, *Los Angeles, California.

The composting systems which will be a major part of the planned program for sludge management in the Los Angeles/Orange County Metropolitan area are discussed. When the LA/OMA project started, windrow composting was thought to offer many advantages, with the major disadvantage being the need for large land areas. Initial efforts were therefore directed at cutting back the needed land areas and reducing the dependence on other bulking agents or amendments. Four years later air drying of digested, dewatered sludge was tested on about 20 acres of land. Dewatered sludge was placed into long piles about 0.3 meters deep and turned periodically to enhance air drying and reduce the moisture content to less than 50% prior to landfill disposal. Actual operating experiences during wet weather confirmed the expected problems and emphasized the importance of wet weather operation. The LA/OMA operating agencies have substantial anaerobic digestion facilities and use the resultant digester gas to partially satisfy treatment plant power demands. Continued use of digester gas is a cost-effective approach to meeting treatment plant power demands. The feasibility of

composting digested sludge in rectangular bins about 3 meters deep was studied. A fully equipped, pilot scale, enclosed reactor composter was also studied. Composting and reuse was judged to have good prospects for inclusion in an overall sludge managment program. However, wet weather problems and odor and dust problems are still to be overcome. (Baker-FRC)
W82-03400

## 5F. Water Treatment and Quality Alteration

**ON WATER AVAILABILITY AND DEMAND IN NIGERIA,**
Ibadan Univ. (Nigeria). Dept. of Geography.
For primary bibliographic entry see Field 6D.
W82-03062

**AN INTRODUCTION TO INDUSTRIAL WATER TREATMENT,**
R. Hill.
Water Services, Vol 85, No 1026, p 399-402, 1981. 4 Fig.

Descriptors: *Water treatment, *Industrial water, Scale, Corrosion, Water quality, Quality control, Chemical reactions, Water hardness, Cooling towers, Sludge.

Water has a variety of uses in industry; for many of these uses it requires additional treatment beyond that received at the municipal water works. Problems arising out of the impurities remaining in the water after regular treatment fall mainly into the category of scale and corrosion. Scale occurs extensively in heating and steam raising plants and also in cooling towers. Scale is the result of the presence in the water of salts of calcium and magnesium, and hardness salts. Corrosion is the loss of metal from the structure containing the water and can happen through erosion, dissolving, and galvanic corrosion. The two distinct areas of water treatment are internal and external. Internal involves the addition of chemicals to a system to inhibit the reactions which cause scale and corrosion. External methods use specially designed items of equipment to remove the impurities which cause the problems. Scale inhibiting chemicals act by allowing hardness salts to precipitate as microcrystals and then adsorbing onto the surface of the crystals to prevent them growing into scale. Corrosion inhibitors work by preventing either or both of the half cell reactions from proceeding. For external processes which remove the impurities, the problem of disposing of them still remains. Sludge from settling tanks, backwash water from filters, and regenerant streams from ion exchange units all contain a high concentration of the impurities that the unit was removing. These effluents have to be disposed of, and this may well create a whole new field of problems to be considered. (Baker-FRC)
W82-03071

**DESIGN AND FABRICATION OF A LOW COST PACKAGE WATER TREATMENT PLANT FOR RURAL AREAS IN INDIA,**
Visvesvaraya Regional Coll. of Engineering, Nagpur (India). Dept. of Public Health Engineering.
A. G. Bhole.
Aqua, No 5, p 315-320, 1981. 10 Fig, 5 Tab, 18 Ref.

Descriptors: *Developing countries, Package plants, *Rural areas, *India, *Water treatment facilities, Design criteria, Pebble bed flocculators, Flocculation, Plate settlers, Settling tanks, Filtration, Chlorination.

A low cost package plant for treating surface waters is presented. Its operation requires no mechanical equipment or electric power except for a diesel pump. The plant does not need a skilled operator, because it is simple to operate and maintain. The design includes an alum dosing unit (large plastic bucket), a tapered pebble bed flocculator which subjects the water flow to decreasing velocity gradients, plate settlers (require one tenth the detention time of conventional clarifiers), a rapid sand filter unit, and a bleaching powder chlorination unit (plastic bucket). The plant, which costs about 1150 pounds sterling, may be easily transported to the desired site. Design for this plant was based on a population of 1000 using 90 liters per hour per day, raw water with average turbidity of 100 NTU, and operation for 8 hours a day initially. (Cassar-FRC)
W82-03115

**NEW TECHNIQUES TO REMOVE RADON FROM GROUND WATER.**
Water Well Journal, Vol 35, No 11, p 16, 18, November, 1981.

Descriptors: *Groundwater, *Water treatment, Activated carbon, Drinking water, *Well water, *Potable water, Carbon, Adsorbents, Aeration, *Radon removal, Radioactivity.

Two methods have been developed for removing the radioactive gas radon from well water. These methods are thought to be 95% or more effective. The two methods, granular activated carbon adsorption and diffused aeration, have been incorporated into commercial units that may be installed in homes at reasonable costs. The methods are augmented by a third process developed by the state, called spray aeration. The activated carbon unit is really nothing more than a commercially available home water softener unit in which the water softening resin is replaced with granular activated carbon. The carbon will remain effective over an indefinite period of time, a priod of years. The diffusion aeration method involves a 40-gallon pressure tank in which a ceramic diffuser creates fine air bubbles in the water. The clean air from the atmosphere in the bubbles will strip the radon from the water; the gas is then vented from the house and released harmlessly into the atmosphere. (Baker-FRC)
W82-03157

**PHYSIOCHEMICAL SPECIATION OF LEAD IN DRINKING WATER,**
Lancaster Univ. Bailrigg (England). Dept. of Environomental Sciences.
R. M. Harrison, and D. P. H. Laxen.
Nature (London), Vol 286, No 5775, p 791-793, August 21, 1980. 2 Tab, 16 Ref.

Descriptors: *Drinking water, *Lead, *Speciation, *Heavy metals, Metals, Physical properties, Chemical properties, Solubility, Plumbing, Water conveyance, Pipes, Flushing.

The speciation of lead was investigated in two tapwater samples consisting of morning first draw water and in one sample taken after thorough flushing of the pipes. The first two samples came from a house in Glasgow with a lead-lined tank and lead piping and a house in Bentham with internal copper piping but a lead service pipe; the sample after flushing came from the University of Lancaster, which had copper piping with high-lead soldered capillary joints. The University sample had a total lead concentration of only 3.3 nanograms per milliliter, most of which was filterable. The water supply for the University had a substantial organic content and showed considerable capacity to complex lead, which was lost following ultraviolet irradiation of the sample water. In the Bentham sample, where the water supply has a low organic content, 53 percent of the lead and 33 percent of the copper were associated with colloidal particles of between 0.015 and 1.0 micrometers, while 19 percent of the lead was in colloids between 1 and 12 micrometers. The Glasgow sample contained the highest concentrations of total lead, most of which was associated with colloidal size fractions between 0.015 and 0.08 micrometers. The three samples each appeared to have little or no free ionic lead. Lead in these samples did not appear to be the result of particles flaking off the basic lead carbonate lining of lead water pipes. Since the solubility of the plumbing depends on the adsorption and complexation capacity of the hydrous oxides and organic complexing agents in the water supply, techniques to control this solvency depend on increasing the pH of the water and its hardness/alkalinity. (Carroll-FRC)
W82-03198

**INACTIVATION OF ENTEROVIRUSES BY OZONE,**
Illinois Univ. at Urbana-Champaign. Dept. of Civil Engineering.
D. Roy, R. S. Engelbrecht, P. K. Y. Wong, and E. S. K. Chian.
Water Science and Technology, Vol 13, No 2, p 819-836, 1981. 11 Fig, 44 Ref.

Descriptors: *Disinfection, *Viruses, *Ozone, Laboratory studies, Water treatment, Wastewater treatment, Kinetics, Microbiological studies, Temperature effects, Hydrogen ion concentration, Mass transfer, Poliovirus, *Enteroviruses.

The effects of pH, temperature, and residual ozone concentration on the inactivation of poliovirus 1 (Mahoney) were studied using a precisely controlled continuous flow reactor. With other parameters constant, the rate of viral inactivation increased as residual ozone increased between 0.1 and 0.2 mg/l (0.1, 0.12, 0.15, and 0.21 mg/l at pH 7.2 and 20 C). Inactivation at a given ozone level was rapid during the initial contact period (up to about 25 sec), then slower to the end of the experiment (140 sec). Viral inactivation was greater at high pH (7.2) than at low pH (4.3 or 5.9). The shape of the survival curve at pH 4.3 suggested that increased resistance to ozone at high pH was due to inherent properties of the virus and was not the result of increased aggregation of the viral particles. The percentage inactivation increased with temperature at the three levels tested (5, 10, and 20 C). Calculation of the activation energy for ozone disinfection (3.6 kcal) from the temperature experiments indicated that mass transfer of ozone into the viral particle, rather than the chemical reaction rate, was the rate-limiting element in viral inactivation. The all-or-none effect reported by previous researchers was notably absent in all the experiments, and thus has probably been a result of experimental error. (Carroll-FRC)
W82-03208

**EMERGENCY WATER SUPPLY GENERAL REPORT NO. 2, CONCEPT FOR AN EMERGENCY WATER SUPPLY IN SWITZERLAND,**
Waterworks, Zurich (Switzerland).
M. Schalekamp.
Aqua, No 4, p 8-14, April, 1980. 16 Fig.

Descriptors: *Disasters, *Water supply systems, *Protection, Nuclear explosions, Electromagnetic waves, Water scarcity, Water storage, Water distribution, *Switzerland.

Switzerland has plans for assuring a water supply in case of catastrophe such as sabotage, natural disaster, war, or nuclear destruction. Water requirements per person per day are three liters for Stage 1 (first three days), 5-15 liters for Stage Two (to the end of the third month), and 25-100 liters during Stage Three (the reconstruction period lasting another nine months). For Stage One supplies, water is being packaged in plastic containers, good for five years storage. For Stage Two, 110 emergency supply points are set up to draw groundwater and spring water. The third stage water supplies will come from three pumping stations built to withstand nuclear attack, electromagnetic pulse (EMP) from nuclear explosions, and other disasters. Protection against EMP is obtained by encasing the whole building in a Faraday's cage, a metal sheath at least three mm thick. RFI doors are used at entrances. Power cables are equipped with excess voltage conductors and must respond seven to ten times faster than normal lightning conductors. Undisclosed security measures to prevent unauthorized entry are also in force. (Cassar-FRC)
W82-03221

**FLUORIDE DETERMINATION IN WATER: AN OPTIMUM BUFFER SYSTEM FOR USE WITH THE FLUORIDE-SELECTIVE ELECTRODE,**

University of Strathclyde, Glasgow (Scotland). Dept. of Applied Geology.
K. Nicholson, and E. J. Duff.
Analytical Letters, Vol 14, No 7, p 493-517, 1981. 1 Fig, 7 Tab, 21 Ref.

Descriptors: *Fluoride, *Water analysis, *Ion-selective electrodes, Reproducibility, *Drinking water, Performance evaluation, Water quality.

Methods used for the determination of fluoride in water analysis were investigated to ensure that the methods were sufficiently sensitive and reproducible for routine use, as long as there is strict control of fluoride levels in fluoridated water supplies. Eleven buffered systems were examined, and maximum complexing ability with optimum reproducibility and sensitivity were determined. Tisab III M.-triammonium citrate was the best of the eleven systems in terms of masking ability. Only Al and Mg pose interference problems. For full decomplexing capacity of the buffer to be exploited, a minimum decomplexing time of 20 minutes, preferably 24 hr, after buffer addition is required. The masking ability and stability of the complex formed by the buffer deteriorates on storage. Buffers should be discarded after two weeks of storage. (Small-FRC)
W82-03259

**WATER SUPPLY IN DENMARK,**
Copenhagen Water Supply (Denmark).
For primary bibliographic entry see Field 6D.
W82-03274

**THE RISK BUSINESS,**
Thames Water Authority (England).
For primary bibliographic entry see Field 6E.
W82-03281

**UPDATING ANTIQUATED CITY WATER SYSTEMS,**
Bogert (Clinton) Associates, Fort Lee, NJ.
W. Wheeler.
Consulting Engineer (St Joseph), Vol 57, No 3, p 101-105, September, 1981, 3 Fig.

Descriptors: *Water supply, *Utility extension, *Water shortage, Water distribution, *Water supply systems, Filtration, Water treatment, Lynn, Massachusetts, Newark, New Jersey, Pipes, Water mains, Pumping plants, Reservoirs, Planning, Maintenance.

The process of expanding old city water systems is illustrated by two examples. In Lynn, Massachusetts, the water supply for this 6800 acre city was insufficient and of poor quality after the droughts of the 1960's. The first phase improvements involved the high service distribution system: pipe cleaning and lining, redistribution of water by installation of valves, and installation of parallel pipes. Pilot plant studies indicated that rapid coagulation-direct filtration would be most suitable and cost effective for a proposed treatment plant. Two 3-million gal storage tanks were built. In the low service distribution system, 60-year old pipes were cleaned and relined with cement. Daily average demand was calculated at 15.5 mgd, but safe yield from existing facilities was only 12.5 mgd. Improvements in pumping capacity and impoundments increased the yield to 17 mgd. An eventual 30 mgd was accounted for in the design. A similar staged program is planned for Newark, New Jersey, to improve the water supply and distribtion system, which is awaiting construction. This consists of a rapid coagulation-direct filtration system with initial 94 mgd capacity and ultimate 136 mgd capacity. A major interconnection project will combine the supply systems of Jersey City, Newark, and the Passaic Valley. (Cassar-FRC)
W82-03293

**AN INTEGRATED MESH-NODAL METHOD FOR STEADY-STATE WATER DISTRIBUTION NETWORK ANALYSIS,**
Victoria Univ. of Manchester (England). Power Systems Lab.
K. R. Stimson, and A. Brameller.
Journal of the Institution of Water Engineers and Scientists, Vol 35, No 2, p 186-187, March, 1981.

Descriptors: *Water distribution, *Systems analysis, Computers, Networks, Computer programs, Algorithms, Mathematical studies, *Water supply systems.

An abstract was formulated of an algorithm and computer program for steady-state analysis of water distribution networks. The algorithm is designed as a mesh method, but is solved by techniques common to nodal methods to produce a fast, reliable, and efficient solution. The inclusion of pumps and control valves and the ability to determine the status of the control valves are also useful. Pumps are modeled as pseudo-pipes, using a given characteristic equation. Pressure reducing valves, pressure sustaining valves, and non-return valves are modeled according to their status. They are modeled in terms of nodes, fixed head nodes, and pseudo-pipes to ensure consistency with the basic formulation. In particular a sub-algorithm is used to determine the status of a control valve when that status is not initially known or is uncertain. The program has been tested on real and hypothetical networks of up to 1600 nodes/2500 pipes with good convergence in every case. This fast analysis method is applicable for interactive simulation and design of water distribution networks. (Baker-FRC)
W82-03305

**MODERN MANAGEMENT TECHNIQUES. PART I: NEED FOR, AND IMPORTANCE OF, PRODUCTIVITY IMPROVEMENT,**
LWFW, Inc., Dallas, TX.
For primary bibliographic entry see Field 6A.
W82-03311

**A CENTURY OF WATER FOR ANTWERP,**
Antwerpse Waterwerken (Belgium).
I. J. Dirickx.
Aqua, No 3, p 10-13, 1981. 1 Tab.

Descriptors: *Utilities, *History, Water treatment, *Antwerp, Belgium, Public utility districts, *Water supply, *Water distribution.

Although the City of Antwerp recognized a need for public water treatment works as early as the cholera epidemic of 1866, it was not successful in establishing a system until 1881, when 7,000 subscribers consuming 2.3 million cu meters a year were served. The distribution system slowly expanded to the 1980 level of 124 million cu meters of water per year and 142,000 subscribers. The water is abstracted from the Albert Canal or the Nete Canal and enters five large storage reservoirs with a total capacity of 2.7 million cu meters. Treatment plants include Notmeir-Walem (165,000 cu meters per day): alum treatment aeration, and sand filtration; Notmeir (220,000 cu meters per day): chlorination, alum and activated silica, dual bed filtration, ozonation, and activated carbon treatment; and Oelegem (135,000 cu meters per day): pumping and purification. (Cassar-FRC)
W82-03355

## 5G. Water Quality Control

**THE AGRICULTURAL IMPACT OF WATER QUALITY STANDARDS: A MATHEMATICAL PROGRAMMING APPROACH,**
R. A. Solove.
PhD Dissertation, 1980. 211 p, 2 Fig, 17 Tab, 83 Ref, 3 Append. University Microfilms International, Ann Arbor, MI; Order No GAX80-25397.

Descriptors: *Water quality control, *Agricultural runoff, *Mathematical models, Cost analysis, Nutrients, Water pollution, Economic aspects, Social values, Pollution taxes, *Florida, Everglades Agricultural Area.

High levels of nutrient pollutants enter water runoff into Lake Okeechobee and the Conservation Areas from the South Florida Everglades Agricultural Area. Lowering the level of nitrogen and phosphorus into these areas will result in both benefits and costs, with expected differential distributive effects across affected groups. Federal and State laws mandating a correction to this externality problem will be associated with varying costs of compliance to the agricultural sector, depending on the specific form of regulation implemented. An agricultural sector, multi-product, price equilibrium mode, which introduces risk into the decision process, was chosen as the tool of analysis. The model allowed achievement of a standard by readjusting crop growing seasons, readjusting water tables, changing relative cropping patterns, and/or readjusting the relative intensity of production in the different subregions. The effluent tax system gave the least reduction in the various social value measures. Compared to the direct regulation approach, the effluent tax yielded nearly $1 M more net farm income at low water quality standards increasing to $32 M at high restriction levels. Results indicate that the effluent tax system may be the least costly method for achieving water quality standards in the Everglades Agricultural Area, increasing in efficiency as standards are made more severe. The implementation, enforcement, monitoring, and transactions costs of various regulatory policies would have to be considered before a charge or tax policy is adopted. (Sinha-OEIS)
W82-03014

**LINERS OF NATURAL POROUS MATERIALS TO MINIMIZE POLLUTANT MIGRATION,**
Arizona Agricultural Experiment Station, Tucson.
W. H. Fuller.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-221863, Price codes: A05 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-122, July, 1981. 5 p, 2 Fig, 2 Tab. R 803988.

Descriptors: *Water pollution prevention, *Linings, *Leachates, *Landfills, Metals, Total organic carbon, Groundwater pollution, Municipal wastes, Solid wastes.

When landfills are not completely impermeable, then underlying groundwater may be contaminated by leachate constituents if these are not adequately retained by soils between the landfill and groundwater. The relative effectiveness of natural low-cost liners, including crushed limestone, clayey soil, hydrous oxides of iron, and crushed pecan hulls, for minimizing the migration of beryllium, cadmium, chromium, iron, nickel, zinc, and total organic carbon constituents of municipal solid waste landfill leachates was investigated in the laboratory. Layers of crushed limestone retarded movement of contaminants through soil. Iron hydrous oxide applied as iron rust was an effective barrier, retarding movement of contaminants so that they appeared much later in effluents. Waste ferrous sulfate treated soils likewise retained metals from leachate, but increased levels of iron were noted in column effluents. There was a significant positive correlation between amounts of iron, manganese and aluminum hydrous oxides in soils and attenuation of metals by these soils. The composition of municipal solid waste leachate exercises a profound influence on retention of metals. Barriers of crushed pecan hulls do not cause retention of sufficient amounts of heavy metals to warrant the effort and expense involved in placement of such barriers. (Moore-SRC)
W82-03028

**USING COHERENT WATER JETS TO CONTROL OIL SPILLS,**
Mason and Hanger-Silas Mason Co., Inc., Leonardo, NJ.
M. K. Breslin.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-232720, Price codes: A06 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-141. August, 1981. 6 p, 1 Tab. 68-03-2642.

Descriptors: *Oil spills, *Cleanup operations, *Water pollution control, *Jets, Wave action,

Water currents, Entrainment, Oil pollution, Oil slicks, Water jets.

The ability of coherent water streams to induce a surface current in a body of water and thus control a floating oil slick was examined in a number of test programs. The objective of the tests was to determine whether coherent water streams could serve as an alternative to fabric booms and water sprays in concentrating, diverting, and containing oil slicks. The water jets were constructed from standard pipefittings and supplied with water from common centrifugal water pumps. The jets were mounted at one of three location; some on the main test tank towing bridge, others onto small floats, and others extending from the bow of a catamaran. Control of oil slicks in 6-knot currents, with water jets, was evaluated by towing the jets with the bridge system at 6 knots. Coherent jets could induce a significant surface current and move an oil slick with litle oil entrainment. Nonbreaking waves produced by a wave generator did not greatly affect performance, except where the jet nozzles were cantilevered off the front of the catamaran and the pitch of the vessel caused significant changes in the height and attitude of the jet outlet. The best position for an unmanned water jet of the sizes and at the pressures tested was determined to be vertically directed at the surface of the water with the outlet 0.4 to 1.0 m above the surface. The vertical component of the coherent water stream was as useful, if not more so, as the horizontal component. (Moore-SRC)
W82-03031

**COMBINED SEWER OVERFLOW ABATEMENT PROGRAM, ROCHESTER, N.Y. - VOLUME I. ABATEMENT ANALYSIS,**
O'Brien and Gere Engineers, Inc., Syracuse, NY.
F. J. Drehwing, C. B. Murphy, Jr., D. J. Carleo, and T. A. Jordan.
Available from the National Technical Information Service, Springfield, VA 22161 as PB81-219602, Price codes: A09 in paper copy, A01 in microfiche. Environmental Protection Agency Project Summary EPA-600/S2-81-113, July, 1981. 4 p. Y-005141.

Descriptors: *Water pollution control, *Combined sewer overflows, *Nonstructural alternatives, *Model studies, *Cost-benefit analysis, Storm water, Water quality management, Storm runoff, Wastewater treatment, *Rochester, New York.

In response to the transient water quality problems induced by periodic overflows from the Rochester Pure Waters District's combined sewer system, a project was undertaken to develop an abatement and management program necessary to achieve a cost effective solution to the combined sewer overflow (CSO) induced impairment of the Genessee River, Irondequoit Bay, and Lake Ontario. The USEPA Stormwater Management Model - Version II, Simplified Stormwater Model, and receiving water models were used to evaluate various CSO pollution abatement alternatives. Nonstructural, minimal structural, and structurally intensive alternatives were defined and evaluated by these models. The nonstructural approach applied Best Management Practices (BMP). Structural alternatives involved evaluation of conventional storage and treatment options. Cost benefit analyses of all structurally intensive alternatives were conducted using optimum treatment process train configurations developed from pilot plant evaluations. Preliminary analysis of BMP and minimal structural alternatives indicated that by addressing the major sources of pollution and by eliminating throttling constraints within the existing sewerage system, a substantial decrease in the total annual load of contaminants to the receiving waters from rainfall induced CSO can be achieved for relatively small capital expenditures. Those measures can be initiated within a short period of time, thereby immediately reducing pollution to the receiving waters, while long term design and construction of more structurally intensive alternatives are undertaken. (Moore-SRC)
W82-03035

**THE DEVELOPMENT OF WATER QUALITY MANAGEMENT PLANS USING DATA FROM AUTOMATIC STORMWATER MONITORING NETWORKS,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
T. J. Grizzard, J. P. Hartigan, and C. W. Randall.
Water Science and Technology, Vol 13, No 8, p 95-102, 1981. 6 Fig, 11 Ref.

Descriptors: Data collections, *Mathematical models, *Water quality management, *Stormwater, *Nonpoint pollution sources, Network design, Networks, Multireservoir networks, Hydrologic data collections, Data processing, Model studies, Water pollution prevention, Water pollution control, Pollution load, *Occoquan Watershed, Virginia.

Data bases constructed at a micro- and macro-watershed in the Occoquan Watershed, Virginia, were used to develop a mathematical model for use as a water quality management aid. This nonpoint pollution source approach provides separate data sets for the necessary calibration and verification studies. Periodic testing of model predictions was carried out through on-going macro-basin data collection to expand the utility of the automatic stormwater monitoring network data base. Thus, the model is equipped to reflect pollution loadings from changing land use patterns. Based on model predictions for present and future land use impacts, the governmental divisions drained by the Occoquan River basin implemented a basinwide nonpoint pollution management program in 1978. This multijurisdictional advisory program depended upon annual reviews of monitoring data and model predictions to calculate cumulative water quality impacts and local reforms in the field of nonpoint water pollution control. (Geiger-FRC)
W82-03069

**1981 REPORT ON GREAT LAKES WATER QUALITY, APPENDIX GREAT LAKES SURVEILLANCE.**
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Water Quality Board.
November, 1981. 174 p. 31 Fig, 77 Tab.

Descriptors: *Water quality, *Water quality management, *Water quality standards, Lake basins, *Eutrophication, Phosphorus, Fisheries, DDT, Toxicity, Degradation, Contamination, Biological oxygen demand, Effluents, Environmental protection, Trout, Alewife, *Toxins, Herring, *Great Lakes.

In this 1981 report the major issues are accelerated eutrophication of the Great Lakes and toxic materials in the ecosystem. Eutrophication impairs recreation, water supply, fishing, and destroys wildlife. Phosphorus was the primary nutrient considered and its control could significantly impede or reverse the eutrophication process. Some success in phosphorus control has been noted, and has resulted in improved drinking water quality, improved recreational use, and some changes in the composition and abundance of fish populations. Total phosphorus levels in Lake Erie's western basin have declined because of decreased loadings from the Detroit River. There has been a possible species change in the phytoplankton as oligotrophic indicator species are more abundant, while the eutrophic species (Scenedesmus spp.) have declined. Total phosphorus levels in Lake Ontario changed little between 1979 and 1980 but a general decline in the last decade is evident. Lake Michigan's total phosphorus levels have been correlated with ice cover vs. year-to-year changes in phosphorus loading. Monitoring programs and surveillance studies in 1980 also revealed the following: DDT and PCBs have declined in bloater chubs and herring gull eggs in Lake Michigan, while dieldrin levels in chubs have increased; the Lake Superior Basin area showed elevated levels of toxaphene in trout but declines in PCBs, DDT, and dieldrin; and dioxin levels in Lake Ontario have been decreasing (from over 1,000 ng/g to under 60 ng/g) over the past ten years. Coordination of surveillance activities needs to be improved and should include the application of resources to priority issues rather than to general basin monitoring. (Atkins-Omniplan)
W82-03101

**1981 REPORT ON GREAT LAKES WATER QUALITY.**
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Water Quality Board.
1981. 74 p. 2 Fig, 3 Tab.

Descriptors: *Water quality, *Water quality management, *Water quality standards, Water pollution control, Effluent limitations, Phosphorus, Pulp and paper industry, Operating policies, Eutrophication, Degradation, Contamination, Biological oxygen demand, Effluents, Environmental protection, *Great Lakes, *Toxins.

The Great Lakes Water Quality Board annually reviews and evaluates the environmental quality of the lakes and the progress made in implementing programs required by the 1978 Great Lakes Water Quality Agreement. This report makes recommendations concerning toxic substances, control programs, phosphorus inputs, the pulp and paper industry, and resources commitments. There is no specific management strategy for directing toxic substances activities. The Board recommends sixteen specific measures to abate toxic health and environmental threats, including establishing inventories of toxic substances and their characteristics, establishing monitoring programs, planning hazard and risk assessment programs, and implementing control programs. Phosphorus removal at municipal treatment plants, in conjunction with limitations on the phosphorus content in detergents, has resulted in an average phosphorus effluent limitation of 1.0 mg/L at all Lower Lakes facilities—a goal not expected to have been met until 1986. The pulp and paper industry has also made progress in reducing its loading of BOD and suspended solids into the lakes. Environmental quality problems may be local, lakewide, or systemwide. The Board has identified 39 areas of concern divided into two categories: areas with significant degradation (Class A) and those with impaired use (Class B). There is a discussion of eutrophication and the contaminants in each lake. Progress has been made in implementing the Agreements's programs, but for continued progress resources must be committed in a cost-effective manner according to the priorities that the Board has established. (Atkins-Omniplan)
W82-03102

**TOXIC SUBSTANCES CONTROL PROGRAMS IN THE GREAT LAKES BASIN.**
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Water Quality Board.
1981. 94 p. 1 Fig, 6 Tab, 1 Append.

Descriptors: *Lakes, *Water quality control, *Water quality standards, *Ecosystems, *Toxicity, Environmental policy, Policy making, International agreements, Chemical wastes, Hazards, Assessments, *Great Lakes basin.

Annex 12 of the 1978 Great Lakes Water Quality Agreement calls for programs to inventory toxic substances, to coordinate air, water and solid waste control programs, and for joint programs to manage hazardous materials. The Toxic Substances Committee established a framework of four basic components to evaluate the toxic substances program management. The first component, an information base, includes source inventories, characteristics of toxic substances, and environmental measurements on actual incidence and accumulation of specific chemical substances. The second element is hazard and risk assessment to decide which chemicals should be most closely monitored and which ones are most likely to cause adverse effects in humans and other environmental sectors. The third component is a set of programs to control the release of toxic substances into the environment, and the fourth is a methodology to evaluate the program's effectiveness and identify any changes or adjustments to the management program. The underlying problem identified by the Committee is the absence of an overall Great Lakes ecosystem strategy for toxic substances control activities that are carried out under various jurisdictions and various pieces of legislation. This fragmentation has caused duplication of effort in

some areas, no coverage in others, and an overall limited management capacity. The U.S. and Canada are working toward a more coordinated effort but since the programs are just developing, the extent to which they will be able to effectively coordinate the toxic substances programs remains to be seen. A full description of the programs, the agencies implementing them, and their objectives is in an appendix. (Atkins-Omniplan)
W82-03103

**REPORT OF THE AQUATIC ECOSYSTEM OBJECTIVES COMMITTEE.**
International Joint Commission-United States and Canada, Windsor (Ontario). Great Lakes Science Advisory Board.
November, 1981. 48 p, 7 Tab, 75 Ref, 1 Append.

Descriptors: *Lakes, *Water quality control, *Water quality standards, *Selenium, *Ecosystems, Toxicity, Fish populations, Drinking water, Water pollution effects, Lake sediments, Fish diets, International agreements, *Great Lakes.

The Aquatic Ecosystem Objectives Committee (AEOC) is responsible for keeping current Annex 1 of the 1978 Great Lakes Water Quality Agreement. In 1980, the Committee recommended that concentrations of total selenium in unfiltered water samples not exceed one microgram/liter to protect aquatic life, concentrations in sediments not exceed five micrograms/gram dry weight to protect aquatic life, and that concentrations in aquatic biota not exceed three micrograms/gram wet weight for predatory fish and mammal protection. Recent studies have confirmed the acute lethality of waterborne selenium to fish; however, dietary selenium may be even more toxic. Water consumed by humans rarely constitutes a health hazard. The AEOC also reconfirmed that mirex and its degradation products should be undetectable in water and aquatic organisms to protect aquatic organisms, fish-consuming birds and animals. The best detection levels for mirex are 0.005 micrograms/liter for water and 0.005 micrograms/gram for biological tissues. The Committee also made recommendations relative to limited use zones, mixing zones, problem areas and/or areas of concern. Mixing zones are the physical expression of water quality objectives and represent within the zone a loss of beneficial use, and, at the edge of the zone, the maximum limit of that loss. Merely identifying a problem area does not describe the extent, severity or significance of the problem and abdicates responsibility for actively limiting its impact. This report outlines the considerations required to formulate mixing zone objectives and the mechanics of establishing a mixing zone. Needs to be considered for 1981-82 are also listed. (Atkins-Omniplan)
W82-03105

**FINAL REPORT, GROUND WATER STUDY, AMES-CAMBRIDGE REACH OF THE SKUNK RIVER, STORY COUNTY, IOWA,**
Iowa State Water Resources Research Inst., Ames.
For primary bibliographic entry see Field 2F.
W82-03112

**PARAMETRIC MODEL AND OPTIMAL PREDICTION OF THE AVERAGE SALINITY OF THE AZOV SEA,**
Academiya Nauk SSSR, Moscow. Inst. Vodnykh Problem.
V. E. Prival'skii.
Water Resources, Vol 7, No 4, p 321-333, July/August, 1980. 4 Fig, 3 Tab, 13 Ref. Translated from Vodnye Resursy, No 4, p 40-54, July/August, 1980.

Descriptors: *Salinity, *Water consumption, *Water management, *Azov Sea, USSR, Model studies, Prediction, Monte Carlo method, Mathematical models, Planning, Ecological effects, *Water quality control.

Nonreturnable water consumption in the Azov Sea basin has increased salinity in the sea from the desired 9.5-11 parts per thousand to 13.9 parts per thousand in 1976. Effective implementation of water-management measures requires a model for predicting average salinity under application of the management variants. A model to predict the salinity on the basis of nonreturnable withdrawals and additional delivery of fresh water was developed and tested. For nonreturnable withdrawals of 25.5 km per year in 2000, salinity would be about 17 parts per thousand, increasing to 19 parts per thousand by 2010. (Cassar-FRC)
W82-03154

**NEW THRUST IN THE 1980S FOR U.S. WATER-QUALITY PROGRAMS,**
Civil Engineering (New York), Vol 50, No 9, p 78-81, September, 1980.

Descriptors: *Water quality, *Policy making, Administration, Standards, Regulations, Water quality standards, Human disease, *Water pollution control.

Changes expected in the water quality program of the United States for the 1980s are discussed. In the 1970s major concern was demonstrated for surface waters such as rivers and lakes. Groundwater and small lakes were for the most part neglected. Now concern over ground water contamination is causing a re-thinking in priorities for the 80s. Progress has been made in controlling point-source pollution. A major problem in this area, however, remains with the municipalities and their low rate of compliance with regulations. Non-point source pollution, however, has been more difficult than point source pollution to control. Controlling turbidity or chemicals entering river water that flows through an area of numerous farms has proven hard to handle in that the source cannot be so readily determined and in many cases is not a single source at all. An important change in thinking has occurred as the move was made away from ambient water quality standards to some kind of technology-based effluent standards. Public opinion is also shifting from the desire to have clean water in the lakes for the sake of healthy fish to the idea that clean water in lakes is healthy for humans. (Baker-FRC)
W82-03252

**RIVER CLEAN-UP PLAN DEVELOPED WITH CITIZENS AND INDUSTRY,**
Fox Valley Water Quality Planning Agency, Neenah, WI.
H. J. Day, W. Elman, D. Theiler, and R. Christianson.
Civil Engineering (New York), Vol 50, No 3, p 78-81, March, 1980. 2 Fig.

Descriptors: *Water quality management, *Public participation, *Industrial wastes, Planning, Alternative planning, *Fox River, *Wisconsin, Pulp and paper industry, Water pollution prevention, Water pollution control, Political aspects, Model studies, Dissolved oxygen, Waste treatment, Low-flow augmentation, Instream aeration, Rivers.

Citizens, state environmental planners, and paper industry representatives have worked together to plan pollution abatement for the lower Fox River, Wisconsin, formerly one of the ten most polluted rivers in the U.S. Organic wastes have been reduced by 90% and final cleanup to meet Clean Water Act standards is in the planning stage. The first step was formation of the Fox Valley Water Quality Planning Agency, comprising three citizens'groups. The second step identified point source pollution and provided for modeling of the river's dissolved oxygen profile. A daily average dissolved oxygen standard of 5.5-6.2 ppm was chosen. An allowable discharge was set for each municipal and industrial discharger. It was decided to use the full assimilative capacity of the river as long as the required water quality standard is maintained. This permits tailor-made discharges but requires more complex stream monitoring and management. Stream management alternatives under consideration are end-of-pipe treatment, low-flow augmentation, and instream aeration. Outfall relocation and instream alteration (removing dams) were rejected as alternatives. (Cassar-FRC)
W82-03283

**EPA MOVING TO CONTROL INDUSTRIAL TOXIC POLLUTANTS WITH NEW NPDES PERMITS,**
Environmental Protection Agency, Boston, MA. Region I.
For primary bibliographic entry see Field 6E.
W82-03296

**DETOXIFICATION OF ZINC AND CADMIUM BY THE FRESHWATER PROTOZOAN TETRAHYMENA PYRIFORMIS. II. GROWTH EXPERIMENTS AND ULTRASTRUCTURAL STUDIES ON SEQUESTRATION OF HEAVY METALS,**
Queen Elizabeth Coll., London (England). Dept. of Biology.
S. Dunlop, and G. Chapman.
Environmental Research, Vol 24, No 2, p 264-274, 1981. 4 Fig, 3 Tab, 22 Ref.

Descriptors: *Protozoa, *Heavy metals, Zinc, Cadmium, Industrial wastes, Aquatic animals, *Detoxification, Decontamination.

Cells of Tetrahymena pyriformis (strain W) were exposed to various concentrations of zinc and cadmium. While 120 ppm zinc or 4 ppm cadmium killed the cells, they survived in 60 ppm zinc or 2 ppm cadmium. The sublethal concentrations of zinc and cadmium limited the cumulative effect of growth as shown by reduced cell numbers. Zinc and cadmium suppressed cell division initially. Zinc-treated cultures recovered somewhat. Growth rates in the cadmium treated cultures were between only 18% and 58% of the controls, giving low cell densities at 40 hr. A slow recovery was noted hereafter. Low zinc (6 ppm) or low cadmium (2 ppm) concentrations did not greatly alter growth characteristics. Zinc at 6 ppm partly annulled the detrimental effect of 2 ppm cadmium. Ultrastructural observations and electron-probe analysis showed that zinc induced the formation of many cytoplasmic granules into which the metal was sequestered and thereby detoxicated. Cadmium was more widely distributed throughout the cells and therefore inflicted more damage. (Baker-FRC)
W82-03334

**A LARGE INTERATIONAL RIVER: THE DANUBE,**
Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest (Hungary). Inst. for Water Pollution Control.
P. Benedek, and F. Laszlo.
Water Science and Technology, Vol 13, No 3, p 61-76, 1981. 8 Fig, 2 Tab, 11 Ref.

Descriptors: *Water quality control, *River basins, *International agreements, Water pollution control, Water management, *Danube River, Rivers, Heavy metals, Self-purification, Bottom sediments, Wastewater disposal, Budapest, Hungary, Water policy, International waters.

The Danube, flowing through eight European countries, is a multipurpose use river of vital importance for 70 million inhabitants. The navigation aspect will increase in the 1980's with the opening of the Rhine-Maine-Danube navigational canal. The Danube, which is suitable for drinking water purposes with simple treatment over almost the entire 2800 km length, is used for hydropower, drinking water, and cooling water. It provides 70% of surface water sources in Hungary, which lies entirely within the Danube basin. Downstream of Budapest, water quality has shown deterioration with increasing levels of Hg, Cd, lubricating oil, and lignin-sulfonic acid. Fortunately, the bank-filtered wells are still of good quality, and bottom sediment analysis shows non-serious levels of heavy metals. Self-purification improves the water quality so that it enters Yugoslavia with a lighter pollutant load. Proposed sewage treatment plants at Budapest and Vienna are expected to improve the water futher. Rapid industrialization and population growth require a comprehensive monitoring and water quality control program on an international scale. (Cassar-FRC)
W82-03369

**REMOVAL OF OIL POLLUTANTS FROM WATER BODIES BY MEANS OF HYDROPHOBIC SORBENTS,**
Akademiya Nauk SSSR, Moscow. Inst. Okeanologii.
M. P. Nesterova, N. M. Anufrieva, A. B. Goritskii, L. M. Shuter, and R. M. Verlinskaya.
Water Resources (English Translation), Vol 7, No 4, p 375-379, July-August, 1980. 2 Tab, 19 Ref. Translated from Vodnye Resursy, No 4, p 156-160, July-August, 1980.

Descriptors: *Water pollution control, *Sorption, *Oil spills, Oil pollution, Water treatment, Sawdust, Perlite.

Hydrophobic sorbents for cleaning up oil spills in surface waters were prepared from perlite or sawdust mixed with dimethyl formaldehyde resin and a latex copolymer of divinyl and methyl methacrylate in a heated vessel, followed by filtration and drying at 100C. Field tests of the products in barriers floating in the Black Sea showed that hydrophobic expanded perlite and dry pine sawdust removed the oil from the water's surface to a degree of 98.5 and 98.2%, respectively, using a sorbent:oil ratio of 1:2. The same conditions, applied to diesel oil removal, produced similar results. Increasing the ratio of sorbent to fuel to 1:1 improved removal to 99.88%. (Cassar-FRC)
W82-03371

**THE RIVER RHINE--TRANS-NATIONAL RIVER BASIN MANAGEMENT DEVELOPING PROGRAMME TO MEET NEW CHALLENGES,**
Nordrhein-Westfalen Landesamt fur Wasser und Abfall, Dusseldorf (Germany, F.R.).
H. Massing.
Water Science and Technology, Vol 13, No 3, p 77-91, 1981. 2 Fig, 1 Tab, 24 Ref.

Descriptors: *Water quality control, *International agreements, River basins, Water pollution control, *Rhine River, Federal Republic of Germany, Water law, Oil pollution, Legal aspects, Water policy, Industrial wastes, Rivers, Self-purification, Water transport, *Industrial wastes.

The Rhine River and its tributaries, flowing through 10 European countries, have been used for centuries for navigation, drinking, and more recently for industry, cooling water, hydropower, irrigation, wastewater discharge, fishing, and recreation. The 1975 status map gives an indication of water quality. Upstream of Lake Constance, the Alp-Rhine water is moderately loaded, Class II. In the High Rhine and Upper Rhine, quality alternates between Class II and Class III, critically loaded. Recovery takes place in the mountains, and Class II-III again prevails until the beginning of the Lower Rhine. Heavy industry and municipal discharges produce heavily, very heavily, and excessively polluted water which exists until the border of Germany and the Netherlands, where it is again Class II-III. Although some improvement in water quality has occurred during the 1970's, further corrective steps are necessary. Control measures, based on the attitude that the drinking water supply is of first importance, are in operation, including treatment of combined sewage overflows, international agreements, and national regulations on discharge of wastewater and individual pollutants, closed cooling systems for power plants, regulation of pollution by ships, artificial aeration, and computerized emission information processing. (Cassar-FRC)
W82-03372

**IN-STREAM AERATION: A POSSIBLE ALTERNATIVE TO AWT.**
Civil Engineering (New York), Vol 50, No 3, p 81-82, March, 1980. 1 Fig.

Descriptors: *Instream aeration, *Aeration, *Advanced wastewater treatment, Fish, Aquatic life, Wastewater treatment, Fox River, Wisconsin, Dissolved oxygen, Oxygenation, Water pollution control.

Instream aeration could achieve the required dissolved oxygen levels in the Fox River, Wisconsin, for an estimated annual cost of $120,000 compared with the $10 million anual cost of additional advanced wastewater treatment. Sidestream pressurization using liquid oxygen is being considered for this river. Advantages include a high transfer rate and an uncluttered surface that would not interfere with recreational boating. There are several unknowns in this field: the effects of aeration on fish and on fish spawning places and the effects of reduced buoyancy. One instream aeration station has been in operation in the Chicago Metropolitan Sanitary District. It pumps diffused air through carborundum plates at the waterway bottom. (Cassar-FRC)
W82-03375

**VACUUM SEWERS--THE FUTURE FOR SEWAGE COLLECTION,**
Willis, Cunliffe, Tait and Delcan, New Westminister (British Columbia).
F. R. King.
Civil Engineering (New York), Vol 51, No 12, p 54-55, December, 1981. 1 Fig.

Descriptors: *Wastewater collection, *Sewers, *Vacuum sewers, Bridgeview, *British Columbia, Sewage collection.

Vacuum sewage collection was the most feasible alternative for Bridgeview, near Vancouver, British Columbia. Located in a flood plain rich in peat, the town had serious sewage contamination from septic tanks and raw sewage leaks. The project, completed in 1980, was 30% cheaper than any other alternative. It included the vacuum collecting network, 2 collecting stations, drainage improvements, installation of ductile iron water mains in place of old wooden mains, and elimination of septic tanks. (Cassar-FRC)
W82-03394

# 6. WATER RESOURCES PLANNING

## 6A. Techniques Of Planning

**A 'RANDOM WALK' SOLUTE TRANSPORT MODEL FOR SELECTED GROUNDWATER QUALITY EVALUATIONS,**
Illinois State Water Survey Div., Champaign.
T. A. Prickett, T. G. Naymik, and C. G. Lonnquist.
Bulletin 65, 1981. 103 p. 68 Fig, 3 Tab, 18 Ref.

Descriptors: Groundwater, *Groundwater movement, Groundwater quality, *Solute transport, *Model studies, *Computer programs, Case studies, Aquifers, Plumes, Groundwater contamination, Finite difference methods, Water pollution, Evaluation, *Surface-groundwater relations.

A generalized computer code is given that can simulate a large class of solute transport problems in groundwater. The effects of convection, dispersion, and chemical reactions are included. The solutions for groundwater flow include a finite difference formulation. The solute transport portion of the code is based on a particle-in-a-cell technique for the convective mechanisms, and a random-walk technique for the dispersion effects. The code can simulate one- or two-dimensional nonsteady/steady flow problems in heterogeneous aquifers under water table and/or artesian or leaky artesian conditions. The program covers time-varying pumpage or injection by wells, natural or artificial recharge, the flow relationships of water exchange between surface waters and groundwater, the process of groundwater evapotranspiration, the mechanism of possible conversion of storage coefficients from artesian to water table conditions, and the flow from springs. It also allows specification of chemical constituent concentrations of any segment of the model. Further features of the program include variable finite difference grid sizes and printouts of input data, time series of heads, sequential plots of solute concentration distributions, concentrations of water flowing into sinks, and the effects of dispersion and dilution or mixing of waters having various solute concentrations.
W82-03007

**OPTIMAL OPERATING POLICIES FOR WATER SUPPLY AND DISTRIBUTION SYSTEMS,**
California Univ., Los Angeles.
J. R. VanWinkle.
PhD Dissertation, 1980. 149 p, 27 Fig, 1 Tab, 34 Ref. University Microfilms International, Ann Arbor, MI; Order No GAX80-16055.

Descriptors: *Water supply, *Water distribution, *Water management, Mathematical studies, Operating policies, Operating costs, Economic aspects, *Inglewood, California.

A method of optimizing the operating policy of a water supply and distribution system using mixed binary programming is presented. The operating policy consists of a set of specific control actions including water treatment levels, the selection of alternative water sources and the determination of pumping schedules which specify the pump flow rates and the timing of the pumping operations. Nonlinear relationships such as the pump characteristic curves and aquifer draw-down are modeled by a linearization technique. A second degree polynominal equation is derived for these nonlinear relationships, and a variable transformation yields a set of equations that are similar in structure to the linearized energy balance equations. These transformed variables are then determined iteratively, in the same manner as the flow rates in the water distribution network. The method was applied to the water supply and distribution system of the City of Inglewood, California. The optimal operating policy developed for this water system resulted in a 13% reduction in operating costs. The case study demonstrated the validity of the method and its rapid convergence towards a balanced solution. (Sinha-OEIS)
W82-03010

**THE INPUT-OUTPUT WATER TRANSACTIONS MODEL OF SUPPLY AND DEMAND,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
For primary bibliographic entry see Field 6D.
W82-03055

**NODAL DOMAIN INTEGRATION MODEL OF UNSATURATED TWO-DIMENSIONAL SOIL-WATER FLOW; DEVELOPMENT,**
California Univ., Irvine. Dept. of Civil Engineering.
T. V. Hromadka, G. L. Guymon, and G. C. Pardoen.
Water Resources Research, Vol 17, No 5, p 1425-1430, October, 1981. 7 Fig, 8 Ref.

Descriptors: *Soil water, *Model studies, Flow, Mathematical studies, Unsaturated flow, Soil moisture, *Flow characteristics, Computer programs, Numerical analysis, Comparison studies.

A basic description of the nodal domain integration procedure is provided, as applied to the class of partial differential equations generally encountered in the theory of unsaturated groundwater flow. Another objective was to develop a numerical statement which represents the finite element Galerkin statement, subdomain numerical statement, finite difference integrated control volume statement, and the nodal domain integration statement by specifying a single parameter in the resulting triangular element matrix system. The resulting statement involves the same computational requirements as does the Galerkin finite element procedure. Thus computer programs may be prepared based on the nodal domain integration procedure, which inherently contains the Galerkin finite element, subdomain, and finite difference techniques. A powerful method of comparing the accuracy of various numerical techniques is provided which eliminates uncertainty of effects between codes used for comparison. The so-called nodal domain integration method theoretically contains all numerical subsets in addition to those derived. For

example, the method would include linear basis function approximations of higher order basis functions. The method proposed in this paper can be extended to include the case where a single computational problem can be allowed to select a spatially and temporarily varying n function to achieve optimal spatial accuracy. (Baker-FRC)
W82-03080

**A PLANNING METHOD FOR EVALUATING DOWNSTREAM EFFECTS OF DETENTION BASINS,**
Maryland Univ., College Park. Dept. of Civil Engineering.
For primary bibliographic entry see Field 4A.
W82-03089

**RELIABILITY PROGRAMING IN RESERVOIR MANAGEMENT 1. SINGLE MULTIPURPOSE RESERVOIR,**
California Univ., Davis. Dept. of Civil Engineering.
S. P. Simonovic, and M. A. Marino.
Water Resources Research, Vol 16, No 5, p 844-848, October, 1980. 3 Tab, 3 Fig, 5 Ref.

Descriptors: *Reservoir operation, *Reservoir construction, *Reservoirs, *Statistical analysis, *Mathematical models, Reservoir releases, Multipurpose reservoirs, Algorithms, Optimization, Systems analysis, Cost-benefit analysis.

Reliability programming was applied to a single multipurpose reservoir to determine the maximum difference between net benefits and yearly risk losses. Constraints include the probabilities of not exceeding specified limits of storage and inequalities which represent constraints on releases and reliability. The input data consist of sequences of monthly inflow, municipal and industrial water demands, and sequences of monthly irrigation demand. The frequency distribution functions of inflows and irrigation demands are obtained by fitting the data with a Pearson type 3 distribution function. A two-dimensional Fibonacci search procedure was developed as a solution algorithm. However, for a larger number of risk variable, this algorithm would not be economical. (Titus-FRC)
W82-03148

**REGIONAL MULTIOBJECTIVE PLANNING OF WATER SUPPLY AND THE DISPOSAL OF RESIDUALS WITH DUE REGARD TO INTRAREGIONAL POPULATION DISTRIBUTION,**
National Inst. for Environmental Studies, Ibaraki (Japan).
Y. Kitabatake, T. Miyazaki, and M. Takahashi.
Environment and Planning A, Vol 12, No 6, p 627-648, June, 1980. 9 Fig, 16 Tab, 18 Ref.

Descriptors: *Water supply, *Population density, *Regional planning, Model studies, Planning, Long-term planning, *Multiobjective planning, Urban planning, Waste disposal, Wastewater treatment, Water quality control, Economic aspects, *Tokyo, Japan, Land use, Costs, Water management.

A model is developed to determine the optimum intraregional population distribution for managing water supply and disposal of residuals. The resulting information is helpful in long-term planning for developing regions. The three objectives of the model are considered in hierarchical order: first, maximum water quality; then, maximum land quality; and finally, minimum economic cost. The three constraints are total population of the several subregions (to be distributed among the subregions), governmental resources (capital and labor), and water intake at the water supply plant necessary to provide a given water quality. The model is applied to the Tama River basin in the Tokyo Metropolitan area. The study region consists of 15 cities, 4 towns, and a 1976 population of 1,711,298. Results show that the most important objective, water quality, determines the spatial allocation of waste disposal activities and that the economic cost factor influences the spatial arrangement of the population. (Cassar-FRC)
W82-03210

**CALCULATOR PROGRAM AIDS LAGOON DESIGN,**
Gutierrez-Palmenberg, Inc., Phoenix, AZ.
R. E. Palmenberg.
Water/Engineering and Management, Vol 128, No 10, p 49-52, 1981. 3 Fig, 2 Tab.

Descriptors: *Lagoons, *Design criteria, Computers, Planning, Decision making, Ponds, Construction.

A program has been developed which gives a trial and error solution to earthwork volumes for lagoons. The program was written for programmable calculators. The program provides the depth of cut, cut volume, fill volume, and net earthwork volume for the balanced cut and fill construction approach. A procedure was worked out for an actual case for two lagoons sharing a common center embankment. The single lagoon and multiple lagoon cases are easily derived from the two-lagoon case and have been left to the reader to develop. The balance cut and fill earthwork calculation represents a good starting point for estimating earthwork quantities for the construction of earthen lagoons. There are several assumptions in the method, including the existence of level ground on the site, that all material excavated in the cut is suitable for use in construction of embankments, and that the lagoons have a rectangular geometry without allowance for large radius curves in corners. It is possible to apply the balanced cut and fill method to obtain a rapid estimate of earthwork quantities and cut depths for the two-lagoon system. (Baker-FRC)
W82-03211

**A SYSTEMS MODEL OF STREAMFLOW AND WATER QUALITY IN THE BEDFORD OUSE RIVER SYSTEM -- II. WATER QUALITY MODELLING,**
Institute of Hydrology, Wallingford (England).
For primary bibliographic entry see Field 5B.
W82-03243

**RELIABILITY PROGRAMMING IN RESERVOIR MANAGEMENT 2. RISK-LOSS FUNCTIONS,**
Institut za Vodoprivredu Jaroslav Cerni, Belgrade (Yugoslavia).
S. P. Simonovic, and M. A. Marino.
Water Resources Research, Vol 17, No 4, p 822-826, August, 1981. 6 Fig, 4 Tab, 11 Ref.

Descriptors: *Reservoir operation, *Risks, *Flood damage, *Drought, Reservoir releases, Economic aspects, Water supply, Water shortage, Reliability programming, Blue Marsh Reservoir, Pennsylvania, Multipurpose reservoirs.

A method for deriving risk-loss functions associated with floods and droughts was determined from existing hydrologic, hydraulic, and economic data using a reliability programming approach. First, a relationship was established between the amount of water excess or shortage and its corresponding reliability level (risk-quantity relations). Second, the excesses or shortages were related to damages (quantity-loss relations). The results of these two steps are combined to form the risk-loss relation. Both flood and water supply risk-loss functions were determined for the Blue Marsh Reservoir, Schuylkill River basin, Pennsylvania, a multipurpose reservoir built for flood control and municipal water supply. This method, concerned only with economic efficiency, does not include loss of life during floods. Necessary input data for calculating the flood risk-loss function are initial reservoir storage, reservoir capacity, water demands from the reservoir pool, reservoir losses, distribution function of the reservoir inflows, convoluted sums of the cumulative distribution functions of reservoir inflows, and reservoir releases (target releases). Necessary input data for determining the water supply risk-loss functions are initial reservoir storage, reservoir capacity, water supply storage, water demands from the reservoir pool, reservoir losses, convoluted sums of the cumulative distribution functions of reservoir inflows, reservoir releases (target releases), average annual water demand for water supply, cumulative distribution functions of streamflow at the intake, and shortage-loss relationships. This approach can also be used in developing the risk-loss functions associated with other reservoir uses: recreation, navigation, and water quality enhancement. (Cassar-FRC)
W82-03245

**THE COMPUTER: WATER MANAGEMENT TOOL,**
Camp, Dresser and McKee, Inc., Clearwater, FL.
R. N. Armstrong, and R. S. Taylor.
Consulting Engineer (St. Joseph), Vol 57, No 3, p 97-100, September, 1981.

Descriptors: *Computer models, *Planning, *Water management, Model studies, Water supply, Water pollution effects, Water shortage, Wells, Combined sewer overflows, Cross Bar Ranch well field, Florida.

Computer models are being used effectively for water supply management. They are effective in prediction, planning, and monitoring supplies; in simulation of the water cycle; in predicting effects of drought, pollution, and salt water intrusion; and in evaluating the role of socioeconomic factors. Several examples of innovative computer modeling for water resources management are described. In Florida the Cross Bar Ranch well field near Tampa Bay was designed, developed, monitored, and managed by computer to ultimately yield 30 mgd for average demand and 45 mgd for peak demand without violating regulations or damaging the aquifer. Water demand and economic impacts of water restrictions were studied in the Metropolitan Washington, D.C. area. Computer analysis of many variables in population, employment, housing, user type, etc. allowed formulation of an effective water management program for this area. Computer models are also used in studying combined sewer overflows, river flows, flood control alternatives, and basic data on the Chesapeake Bay and its tributaries. (Cassar-FRC)
W82-03290

**MODERN MANAGEMENT TECHNIQUES, PART II A: CASE HISTORY OF PRODUCTION IMPROVEMENT,**
LWFW, Inc., Dallas, TX.
G. S. Thompson, and T. G. McCoy.
Water/Engineering and Management, Vol 128, No 3, p 88-89, 100, March, 1981. 8 Fig.

Descriptors: *Management planning, *Sewer systems, *Water conveyance, Performance evaluation, Economic aspects, Political aspects, Mechanical equipment, Needs assessment, Productivity, Wastewater managment.

An outside consultant was hired to conduct an operation audit of the field operations group of the water and sewer utilities department of a major Texas city in order to obtain an objective review of productive levels, to design and implement a management reporting system that would include productivity performance reporting, and to ensure that the best available management techniques were being used by the field operations group. Initial activities included interviews with key management and supervisory personnel and detailed field observations of the work crews. Later activities included review of planning, scheduling, and reporting functions. Detailed analyses of crew time in the water and sewer construction section revealed severe work imbalances, resulting in low job site productivity. The acquisition of larger back-hoe equipment was recommended and implemented, resulting in productivity improvements between 75 and 90 percent. Analysis and optimization of the size and number of dump trucks used at each site resulted in truck utilization of 83 percent and backhoe utilization of 100 percent, compared to 100 percent and 50 percent, respectively, prior to the evaluation. (Carroll-FRC)
W82-03310

**MODERN MANAGEMENT TECHNIQUES. PART I: NEED FOR, AND IMPORTANCE OF, PRODUCTIVITY IMPROVEMENT,**
LWFW, Inc., Dallas, TX.
G. S. Thompson, and T. G. McCoy.

Water/Engineering and Management, Vol 128, No 2, p 52-54, 64, February, 1981. 2 Ref.

Descriptors: *Water treatment facilities, *Management planning, *Productivity, Labor, Wastewater management, Sewer systems, Supervisory control, Operating policies, Decision making, Administration, Utilities.

Problems caused by declining productivity in the public sector become manifest through increased costs of service, declining service levels, and inability to adequately maintain and replace existing capital systems and equipment. When planning productivity improvements in the field operations area of water and sewer utilities, it is first necessary to define productivity and to determine who in the organization can implement its improvement. Labor productivity should be the major focus, since field operations activities are labor intensive and because labor productivity can be significantly influenced by management action. Major factors affecting field operations productivity include work methods, scheduling, materials availability, equipment, proper management information, tactical planning, and strategic planning. Because of the importance and complexity of productivity in this area, its improvement requires the best available management techniques, including productivity performance reporting as an integral part of a management information system, the use of the critical success factors approach to organizational design and management, and periodic operations audits. Productivity performance reporting is the reporting through all levels of supervision and management of the productivity of each segment of the operation. Critical success factors are those important factors requiring special management attention. Individuals should be charged with accountability for each of the identified factors. Operations audits provide a tool for focusing on the review of the operation as a whole, for evaluating the effects of management actions on productivity, and for early identification of problem areas. (Carrol-FRC)
W82-03311

**JERSEY DROUGHT HASTENS WATER SUPPLY PROJECT,**
American Society of Civil Engineers, New York.
For primary bibliographic entry see Field 6D.
W82-03385

## 6B. Evaluation Process

**ALTERNATIVE COSTS AND TOTAL ECONOMIC BENEFITS: AN INPUT-OUTPUT STUDY OF THE ASWAN DAM (EGYPT),**
Northeastern Univ., Boston, MA. Dept. of Economics.
M. E. S. Abdel Rahman.
PhD Dissertation, July, 1980. 163 p, 25 Tab, 62 Ref, 3 Append. University Microfilms International, Ann Arbor, MI; Order No GAZ81-07001.

Descriptors: *Economic aspects, *Model studies, *Cost-benefit analysis, *Dams, Electric power, Irrigation, *Aswan Dam, Egypt.

This study empirically assesses the alternative costs and total (direct and indirect) economic benefits of the Aswan Dam to the Egyptian economy. The chief analytical tool is a static version of Leontief's Input-Output model. The alternative costs are the net drain on the economy of using other methods to produce an amount equal in value to the electrical power and agricultural output made possible by the water supply of the Dam. The estimated alternative costs show the Dam to be a very efficient source of electric power and of water for irrigating additional land and hence to be economically justified in these terms alone. The total benefits encompass the expected increase in the demand for the Dam's extra electric power and agricultural production. The total benefits from the additional electricity can be analyzed in terms of the increases in domestic sector's output, employment, and contribution to the balance of payments position of the country. National policy implications of the study are that the Aswan Dam is the basis for future economic development in Egypt. If the maximum benefits of its electric power are to be realized, Egypt's development policy should emphasize the allocation of the country's limited investment funds to the creation and/or expansion of a 'growth industry' in each of the economy's key processing sectors with the strongest forward linkages. These sectors are found to be: chemicals; food processing; spinning and weaving; iron and steel. Two other key primary sectors should continue to be developed, namely transportation and agriculture. (Sinha-OEIS)
W82-03009

**OPTIMAL OPERATING POLICIES FOR WATER SUPPLY AND DISTRIBUTION SYSTEMS,**
California Univ., Los Angeles.
For primary bibliographic entry see Field 6A.
W82-03010

**LABORATORY STUDIES OF PRIORITY POLLUTANT TREATABILITY,**
Walk, Haydel and Associates, Inc., New Orleans, LA.
For primary bibliographic entry see Field 5D.
W82-03030

**COMBINED SEWER OVERFLOW ABATEMENT PROGRAM, ROCHESTER, N.Y. - VOLUME I. ABATEMENT ANALYSIS,**
O'Brien and Gere Engineers, Inc., Syracuse, NY.
For primary bibliographic entry see Field 5G.
W82-03035

**COST-BENEFIT ANALYSIS OF THE EUPHRATES DAM,**
Norfolk State Univ., VA.
N. Samman.
Water Suply and Management, Vol 5, No 4/5, p 331-338, 1981. 1 Fig, 1 Tab, 29 Ref.

Descriptors: *Dams, *Decision making, Management, Planning, *Euphrates Dam, *Syria, *Euphrates river, Rivers, Dam construction, Construction, Irrigation, *Cost-benefit analysis, Economic aspects, Cost analysis, Multipurpose reservoirs.

In Syria, the economy is primarily agricultural. Agricultural production varies due to the annual rainfall, which at present is only 350 mm/year. However, an abundance of natural water resources are available for agricultural use. A dam was constructed across the Euphrates River in 1975 and has increased actual and potential irrigation in the river basin. With completion of the dam, irrigation objectives of 640,000 hectares can be developed over the next 20-30 years in the Euphrates Basin. Considering the costs and benefits of the project involves making certain assumptions. First, the project life is 35 years, even though the economic benefits extend to a century. Secondly the social infrastructure costs associated with farmer resettlement in the project area, including public buildings, roads and public utilities are not imputable to the project, as these facilities have to be provided by the government with or without the project. Third, the investment stream in the economic analysis comprises the following five items: initial fixed investment, investment imputable to the project, operation and maintenance costs, investment for removal of appropriate items which depreciate, and annual costs at the farm level. Fourth, the social opportunity cost of family labor was assumed to be zero. Analysis revealed that the project was economically sound and justified its priority consideration by the Syrian Government. However, it also seemed that the project will not transform the Syrian economy to the extent expected by the planners. (Baker-FRC)
W82-03054

**ESTIMATING THE COSTS IN LOST POWER OF ALTERNATIVE SNAKE-COLUMBIA BASIN MANAGEMENT POLICIES,**
Sandia National Labs., Albquerque, NM.
R. J. Hanson, and C. B. Millham.
Water Resources Research, Vol 17, No 5, p 1293-1303, October, 1981. 3 Fig, 6 Ref.

Descriptors: *Cost analysis, *Model studies, Benefits, *Water management, Water use, Water resources development, Basins, Watersheds, Powerplants, Project planning, Alternative planning, *Snake River basin, *Columbia River basin.

Competition exists between optimal hydropower generation on the one hand, and recreation, fisheries, navigation and irrigation on the other. Specific questions resulting from this conflict deal with the costs of replacing hydropower lost under alternative basin management schemes designed to benefit uses other than power generation. A 51 dam, 56 time period long range simulation model of the hydropower system in the Snake-Columbia basin, including projects on those two rivers and on major tributaries thereof is presented. The model is then applied to study a series of alternative basin management scenarios, and the consequences in lost power of these scenarios are evaluated economically. Efficiency in this model was achieved using 'French Curve' cubic spline data fits together with fast pointers to carefully define data structures. Care was taken to couch the model in a setting making it accessible to use by nonprogramers. It was concluded that competition between power production and other uses of the basin's water can be expected to increase as energy shortages increase. Trade-offs between power production and the other uses and interests must be evaluated and decisions made as to which interests to favor. The results given herein are linear in terms of changes in costs for either base-load or peaking. For example, an error of two mills in peaking costs would result in a change of about $4,000,000, for a deficit of 3000 megawatt-months. The power deficits, in megawatt months, are felt to be reasonably good estimates. There is some room for discussion of the split between baseload and peaking. (Baker-FRC)
W82-03073

**ECONOMIC APPRAISAL OF A GROUNDWATER DEVELOPMENT PROJECT,**
Asian Inst. of Tech., Bangkok (Thailand). Div. of Industrial Engineering and Management.
J. C. S. Tankg, and S. Tanthimakabut.
Water Resources Bulletin, Vol 17, No 5, p 783-788, October, 1981. 7 Tab, 3 Ref.

Descriptors: *Cost-benefit analysis, *Irrigation water, *Groundwater irrigation, *Irrigation operation, *Thailand, Water distribution, Feasibility studies, Pipes, Economic aspects, Water resources development, Development countries.

A cost-benefit analysis of a groundwater irrigation water development project in northern Thailand indicated that the project is economically feasible. It is designed to provide water for dry season cropping. Major products are soybeans, mung beans, maize, groundnuts, cotton, rice, vegetables, fruits, and sugar cane. Benefit-cost ratios for two cropping patterns were 1.42 and 1.35 (financial) and 1.94 and 2.07 (economic with selective shadow pricing). Underground PVC pipes are more economical than a lined open ditch system if the ditches must be redone four times over the project life. (Cassar-FRC)
W82-03077

**AN ECONOMIC ANALYSIS OF WATER CONSERVATION POLICY,**
Rutgers - The State Univ., New Brunswick, NJ.
W. Whipple, Jr.
Water Resources Bulletin, Vol 17, No 5, p 814-819, October, 1981. 2 Fig, 1 Tab, 14 Ref.

Descriptors: *Water conservation, *Drought, *Economic evaluation, Water demand, Water supply, Water resources, New Jersey, Water policy, Water reuse, Water prices, Groundwater management.

Disagreement is expressed with Federal policies which encourage water conservation as an end in itself. Although water conservation in drought situations is advantageous and often necessary, it is not a substitute for improved structural systems. Water conservation should be used only when the value of the water saved exceeds the cost of pro-

ducing the savings. A community can be caught unprepared for drought or growth in water demand if it relies on conservation measures during normal rainfall. This policy applies where water is a renewable resource, not where groundwater is mined, such as the Ogallala Aquifer, the Tucson basin, and the Libyan desert. New Jersey is used in an example of an economic analysis. (Cassar-FRC)
W82-03090

**POTENTIAL WATER USE AND AGRICULTURAL PRODUCTION PATTERNS UNDER ALTERNATIVE WATER PRICES,**
Iowa State Univ., Ames. Center for Agricultural and Rural Development.
D. A. Christensen, E. O. Heady, and A. S. Morton.
Water Resources Bulletin, Vol 17, No 5, p 844-850, October, 1981. 7 Fig, 5 Tab, 11 Ref.

Descriptors: *Water demand, Water price, *Agriculture, *Irrigation, Water consumption, *Water cost, Water conservation, Water use, Prices, Crop yield, Model studies, Elasticity of demand, Groundwater irrigation, Surface water, Land use.

The effects of varying prices of surface and groundwater on agricultural land use patterns were determined by normative analysis. Using four levels of prices for both surface water and groundwater and ignoring constraints such as subsidies and water rights, the model produced different amounts of water used and different mixes of crops, livestock, and production technology for each price level. At the highest water prices (4 times 1975 prices for both surface water and groundwater) total water demand is half that of the 1975 base level; irrigated acreage is reduced to 8.4 million from 19.6 million. In practice, marginal dryland regions would be added to the total dryland cropping area. Although irrigated crop yields are reduced and commodity shadow prices are increased by up to 15% at the high water prices, total agricultural production would remain somewhat constant. (Cassar-FRC)
W82-03092

**WHO WILL PAY THE WORLD'S WATER BILL,**
Earthscan, London (England).
J. Tinker.
Aqua, No 3, p 17-20, 1981.

Descriptors: *Developing countries, *Water supply development, International Drinking Water Supply and Sanitation Decade, Water policy, Costs, Planning, Financing, Public health, Rural areas.

A minimum of $300 billion total or $80 million a day is required to meet the goals of the International Drinking Water Supply and Sanitation Decade by 1990. Although agencies and governments are highly in favor of the project, money will apparently come from reducing expenditures in agriculture, health, education, etc. Progress varies according to the country and depends on motivation. For example, Bangladesh expects to reach its 100% coverage goal by 1985, having already sunk half a million tubewells and supplied 70% of the people with a hand pump within 200 meters of their homes. (Cassar-FRC)
W82-03280

**THE GEZIRA SCHEME--A STUDY IN FAILURE,**
N. Pollard.
Ecologist, Vol 11, No 1, p 21-31, January-February, 1981. 1 Fig, 117 Footnotes.

Descriptors: *Social impact, *Human diseases, *Irrigation, Water resources development, Gezira, *Sudan, Cotton, Water management, Agriculture, Developing countries, Environmental effects.

Water resources were developed for irrigation of cotton in the Gezira region, Sudan, starting with the construction of the Sennar dam and canals in 1914. The project has increased in incidence of waterborne disease and disrupted the cultural life of the population without producing much economic gain. Schistosomiasis, malaria, and yellow fever became major problems. Byssinosis affected many cotton gin workers. Simple irrigation has been in use here since 3000 B. C. Before British colonial intervention the population lived in balance with the environment. The family unit and the Muslim religion were the basis of cultural stability. Cotton had been grown, spun, and woven in family units. This practice declined as cotton was sent directly to gins. Land was divided into small plots of 12-16 hectares for working by tenant families. This was not successful because of burdensome government regulations on crop allocation and water management. Proceeds from the cotton crop rarely reach 100 pounds per tenant per year. Although the colonialists have left the area, the Gezira people have a legacy, a technology unsuitable for the cultural environment. (Cassar-FRC)
W82-03393

## 6C. Cost Allocation, Cost Sharing, Pricing/Repayment

**BETTER WAYS TO FINANCE STORMWATER MANAGEMENT,**
Stormwater Consultants, Bolingbrook, IL.
H. G. Poertner.
Civil Engineering (New York), Vol 51, No 4, p 67-69, April, 1981. 2 Tab.

Descriptors: *User charges, *Storm water, *Urban runoff, Financing, Management, Utilities, Storm drains, Institutions, Storm runoff, Urban drainage, Runoff, Planning, Surface drainage, Surface runoff, Cities, Economics, Public utilities, Impervious soils, Legal aspects.

Annual losses and damages from surface runoff in the U.S. were estimated at $3 billion in 1978. Innovative financing methods are frequently needed for preventive and corrective programs. Some cities have adopted the user charge concept, which in Denver, Colorado, uses the ratio of impervious area to total area of a land parcel to determine the rate ($0.37 to $1.17) per 100 sq ft, billed annually, needed to raise $4.7 million a year. Other cities charge according to amount of impervious area or according to land use. The separate stormwater utility is popular in many western U.S. cities. Before establishing any of these systems, legal and public relations efforts should be initiated. (Cassar-FRC)
W82-03298

**MAJOR CHANGES AHEAD IN THE NATION'S WATER CLEAN-UP PROGRAM,**
G. Dallaire.
Civil Engineering (New York), Vol 51, No 12, p 50-53, December, 1981.

Descriptors: *Grants, *Wastewater treatment, *Water pollution control, Water policy, Regulations, Federal jurisdiction, Construction costs, Water quality standards, Effluent standards, Utilities, Standards, Municipal wastewater, Secondary wastewater treatment, Financing, Water quality control.

Changes in federal policies indicate that the construction grants program will be discontinued. The Water Pollution Control Federation urges an orderly phaseout over 10 years to allow municipalities time to adjust to self-reliance. The wastewater treatment plants will have to operate as utilities, charging rates high enough to cover operation and maintenance costs plus replacement costs. With less federal money available officials must concentrate on projects probably in urban areas, which give the most benefit for the least cost. Effluent standards and water quality standards must also become more flexible, perhaps allowing a limited mixing zone in a receiving stream where dissolved oxygen would be permitted to fall to 3 mg per liter instead of 5 mg per liter. Such policies would prevent spending large amounts of money for very small improvements in water quality. Since $120 billion is needed for municipalities to meet the goal of fishable, swimmable waters throughout the U.S., it may be advisable to set up a priority system to first clean up important rivers rather than inadequately deal with many rivers. Policies toward ocean dumping and secondary treatment for effluents disposed of into the ocean may be relaxed. (Cassar-FRC)
W82-03395

## 6D. Water Demand

**WATER RESOURCES APPRAISAL FOR HYDROELECTRIC LICENSING; PIGEON RIVER BASIN; NORTH CAROLINA, TENNESSEE,**
Federal Energy Regulatory Commission, Washington, DC. Office of Electric Power Regulation.
Available from the National Technical Information Service, Springfield, VA 22161 as DE82-003537, Price codes: A03 in paper copy, A01 in microfiche.
Federal Energy Regulatory Commission Report FERC-0087, September, 1981. 45 p, 8 Fig, 11 Tab.

Descriptors: *Water resources development, *River basin development, *Water demand, *Hydroelectric plants, Water quality, Streamflow, Recreation, Water supply, Water storage, Reservoirs, *Pigeon River basin, North Carolina, Tennessee, Licensing.

The Pigeon River basin extends generally northward from the western slopes of the mountains in the Pisgah National Forest in Haywood County, North Carolina, into Cocke County, Tennessee, where the Pigeon River flows into the French Broad River. The Pigeon River drains an area of 666 sq mi. The average annual precipitation is about 45 inches, and the average streamflow of the Pigeon River at its mouth is approximately 1,250 cfs. The area is predominantly agricultural, and sparsely populated. The 108,600 kw Walters hydroelectric project is the only utility generating facility in the basin. Champion Papers, Inc., operates a 51,000 kw industrial steam-electric facility in the upper reaches of the basin. The water resources of the basin have been developed to provide a moderate amount of hydroelectric power with small incidental flood control, municipal and industrial water supplies, and limited fishing and recreation. There are no navigational facilities in the basin. The Walters project consists of a reservoir, dam, and powerplant connected to the reservoir by a 6.2 mi penstock tunnel. The 340-acre reservoir, Waterville Lake, has a total storage capacity of 25,000 acre-ft. Hydroelectric power development potential exists at two sites in the basin, but these projects have not been evaluated for economic feasibility. The Walters project, for which an application for a new license is pending, is in good condition and continued operation of the project appears to be economically justified and would have little impact on the environment. (Moore-SRC)
W82-03039

**WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING; CAPE FEAR RIVER BASIN; NORTH CAROLINA - SOUTH CAROLINA,**
Federal Energy Regulatory Commission, Washington, DC. Office of Electric Power Regulation.
M. Maslia.
Available from the National Technical Information Service, Springfield, VA 22161 as DE82-003334, Price codes: A02 in paper copy, A01 in microfiche.
Federal Energy Regulatory Commission Report FERC-0088, September, 1981. 14 p, 2 Fig, 7 Tab.

Descriptors: *Water resources development, *River basin development, *Water demand, *Hydroelectric plants, Cooling water, Powerplants, Flood control, Navigation, Nuclear powerplants, Thermal powerplants, *Cape Fear River basin, North Carolina, South Carolina, Licensing.

The Cape Fear River basin covers a drainage area of 8,570 sq mi, and this report also includes 1,814 sq mi of the coastal area between the Neuse and Pee-Dee River basins. The average annual rainfall over the basin is about 48 inches. The maximum flow at Lillington is 150,000 cfs, while the minimum flow is 11 cfs. There is one existing Federal flood control project in the basin, and 35 retired

hydroelectric projects. Navigation facilities consist of three channels and three locks and dams. There are two fossil-fueled steam-electric generating plants and one nuclear-fueled steam-electric generating plant operating in the basin; all three use the Cape Fear River as their source of cooling water. The estimated 1977 total cooling water withdrawn was 153 MGD and the estimated consumption was 6 MGD. There is substantial undeveloped hydroelectric power potential in the basin. Potential hydroelectric projects with an existing dam would provide 50,296 kw of additional hydroelectric capacity. Potential hydroelectric projects with no present development at the site would provide more than 144,372 kw of additional hydroelectric capacity. Hydroelectric power development potential also exists at the retired projects. (Moore-SRC)
W82-03040

**WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING; MERRIMACK RIVER BASIN; NEW HAMPSHIRE, MASSACHUSETTS,**
Federal Energy Regulatory Commission, New York. New York Regional Office.
P. Valeri.
Available from the National Technical Information Service, Springfield, VA 22161 as DE82-00356, Price codes: A02 in paper copy, A01 in microfiche. Federal Energy Regulatory Commission Report FERC-0091, September, 1981. 21 p, 2 Fig, 7 Tab.

Descriptors: *Water resources development, *River basin development, *Hydroelectric plants, Licensing, *Water demand, Eutrophication, Water quality, Water storage, Flood control, *Merrimack River basin, New Hampshire, Massachusetts.

The Merrimack River basin is located in south-central New Hampshire and north-eastern Massachusetts, and drains 5,010 sq mi. The average annual precipitation in the basin is 43 inches. The average annual flow of the Merrimack River at Lowell, Massachusetts is 7,480 cfs. The economy of the basin is based largely on manufacturing and service industries. Many segments of the Merrimack River and its tributaries have been seriously polluted, and lake eutrophication is a basinwide problem. There are about 458,000 acre-ft of usable water storage capacity. Five major flood control reservoir projects with a total storage capacity of 370,000 acre-ft have been constructed in the New Hampshire portion of the basin. There are 22 existing hydroelectric plants operating in the basin, with a total installed capacity of 58,048 kw. There are also two steam-electric, three internal combustion, and two combustion turbine generating plants in the basin. There are 46 hydroelectric sites in the basin with a total potential capacity of 323,871 kw, and five existing developments having a potential of increasing their capacity by 51,900 kw. Construction of the new Lawrence powerplant and the proposed Lowell powerplant will provide a total of 29,800 kw. The development of 14 new sites would account for 212,544 kw. Rehabilitation of 25 retired sites currently under license or preliminary permit action accounts for 29,627 kw of potential capacity. There are 389 known retired plants. (Moore-SRC)
W82-03041

**WATER RESOURCES APPRAISALS FOR HYDROELECTRIC LICENSING; YADKIN-PEE DEE RIVER BASIN; NORTH CAROLINA, SOUTH CAROLINA, AND VIRGINIA,**
Federal Energy Regulatory Commission, Washington, DC. Office of Electric Power Regulation.
H. D. Patrick.
Federal Energy Regulatory Commission Report FERC-0090, September, 1981. 15 p, 2 Fig, 6 Tab.

Descriptors: *Water resources development, *River basin development, *Water demand, Licensing, *Hydroelectric plants, Recreation, Consumptive water use, Cooling water, Water supply, Powerplants, Wild rivers, Wildlife, *Yadkin River basin, *Pee Dee River basin, North Carolina, South Carolina, Virginia.

The Yadkin-Pee Dee River basin covers approximately 17,890 sq mi in Virginia, North Carolina, and South Carolina. Precipitation averages about 47 inches per year over the basin. There are eight existing hydroelectric projects with a combined total capacity of 311,329 kw. In addition, there are 16 retired small hydro plants located in the basin. The W. Kerr Scott reservoir on the upper portion of the Yadkin River is the only existing Federal reservoir project in the basin. At present, the project has no power facilities. Water supply for domestic purposes, industry, and agriculture is a major resource use. Over 200 water supply systems have been identified in the basin, of which 60 use surface water. Previous recreational use of the basin has been limited, but the use of the basin for recreational and wildlife is expanding. There are five steam-electric plants which withdraw 1,020.7 MGD for cooling water use, of which 23.7 MGD is consumed. There are 25 potential hydroelectric power developments in the basin, with a total installed capacity of 467,922 kw. Demand for water by public water systems, industrial plants, and for irrigation is expected to rise from approximately 287 MGD at present to 625 MGD by 2010. Potential water supply projects include two dams in North Carolina. Certain segments of rivers within the Yadkin-Pee Dee River basin have been selected as having potential for further consideration for the National Wild and Scenic Rivers System. (Moore-SRC)
W82-03042

**WATER RESOURCES APPRAISAL FOR HYDROELECTRIC LICENSING; PAYETTE RIVER BASIN, IDAHO.**
Federal Energy Regulatory Commission, San Francisco, CA. San Francisco Regional Office.
Available from the National Technical Information Service, Springfield, VA 22161 as DE82-003535, Price codes: A03 in paper copy, A01 in microfiche. Federal Energy Regulatory Commission Report FERC-0089, September, 1981. 52 p, 6 Fig, 10 Tab, 10 Ref.

Descriptors: *River basin development, *Water demand, *Water resources development, *Hydroelectric plants, *Irrigation, Water storage, Reservoirs, Dams, Flood control, Pumped storage, Licensing, *Payette River basin, Idaho.

The Payette River basin is a major tributary of the Snake River draining about 3,240 sq mi in west central Idaho. The average streamflow of the Payette River near Payette is 3,078 cu ft/sec. Annual precipitation varies from 13 inches at Emmett to 22 inches at Cascade and 33 inches at Deadwood Dam. The population in the basin is estimated to increase from 33,427 to 41,962 during the period 1980-2000. There are only two existing hydroelectric developments in the basin: the 8,000 kw Black Canyon plant located downstream of Black Canyon Dam and the unlicensed 300 kw Cascade plant located about 1,000 ft downstream of Cascade Dam. A license has been issued for a 12,800 kw hydroelectric project to be located downstream from the Cascade Dam and Reservoir, replacing the existing powerplant. There are five existing water storage reservoirs, with an aggregate usable storage capacity of 912,000 acre-ft. In 1976 there were about 152,000 acres of irrigated cropland. An additional 10,000 acres of new irrigation development and 23,000 acres requiring supplemental irrigation water supply are proposed by the year 2000. The total potential undeveloped conventional hydroelectric capacity in the basin is estimated to be 1,270 mw. There are two potential pumped storage developments in the basin with an estimated capacity of 1,000 to 3,000 mw and 1,000 to 9,000 mw, respectively. Structural development for the exclusive purpose of flood control cannot be justified under existing evaluation criteria. (Moore-SRC)
W82-03043

**WATER RESOURCES APPARISALS FOR HYDROELECTRIC LICENSING; ST. JOSEPH - KALAMAZOO RIVER BASIN; INDIANA - MICHIGAN,**
Federal Energy Regulatory Commission, Chicago, IL. Chicago Regional Office.
T. P. Mabini.
Available from the National Technical Information Service, Springfield, VA 22161 as DE82-003333, Price codes: A02 in paper copy, A01 in microfiche. Federal Energy Regulatory Commission Report FERC-0093, September, 1981. 18 p, 4 Fig, 6 Tab.

Descriptors: *Water resources development, *River basin development, *Hydroelectric plants, Licensing, *Water use, Flood control, Cooling water, Wild rivers, Powerplants, Streamflow, *St. Joseph River basin, *Kalamazoo River basin, Indiana, Michigan.

The basin includes the drainage areas of the St. Joseph and the Kalamazoo Rivers, with a total area of 6,665 sq mi. Springs and small lakes sustain the flow of the St. Joseph River, and therefore it is not subject to extremely low flows. The streamflow, about 45 mi above Niles, Michigan, averages about 3,100 cu ft/s. The flow of the Kalamazoo River near Fennville, Michigan averages about 1,400 cu ft/s. There are about 15 hydroelectric projects in the basin, with a total installed capacity of 32,478 kw. There are six authorized navigation projects and one local flood control project in the basin. There are five steam-electric plants which rely on surface waters for condenser cooling. One undeveloped hydroelectric site and five developed sites have potential for capacity additions. There are numerous sites within the basin where hydropower was generated but operations have been suspended and the powerhouse either abandoned or removed. A portion of the Paw Paw River, beginning 2 mi downstream of the Berrien-Van Buren County line was studied for inclusion in the National Wild and Scenic Rivers system. The retired Paw Paw hydroelectric projected may be affected by the proposed inclusion. Projected cooling water needs for steam-electric generation decreased due to reduction of plant capacities utilizing once-through cooling systems and an increase of plants utilizing cooling tower systems. (Moore-SRC)
W82-03044

**WATER RESOURCES APPRAISAL FOR HYDROELECTRIC LICENSING; YAMPA RIVER BASIN; COLORADO, WYOMING.**
Federal Energy Regulatory Commission, San Francisco, CA. San Francisco Regional Office.
Available from the National Technical Information Service, Springfield, VA 22161 as DE82-003538, Price codes: A03 in paper copy, A01 in microfiche. Federal Energy Regulatory Commission Report FERC-0086, September, 1981. 51 p, 4 Fig, 5 Tab, 8 Ref.

Descriptors: *Water resources development, *River basin development, *Water damand, *Hydroelectric plants, Dams, Irrigation, Water supply, Cooling water, Powerplants, Reservoirs, Wild rivers, Coal mining, Oil shale, Licensing, *Yampa River basin, Colorado, Wyoming.

The Yampa River basin, encompassing approximately 9,530 sq mi, lies in the northwest corner of Colorado and southcentral part of Wyoming. The major use of water in the basin is irrigation. The municipal systems derive their water from the nearby stream or, in one case, from a ground water reservoir. The only significant industrial water use is for steam-electric generation. As a part of the Colorado River system, flows are subject to requirements imposed by the Upper Colorado basin compact of 1948. The six major reservoirs in the basin are used for irrigation, fishery, domestic consumption, and recreation. The Yampa River basin is undergoing substantial economic development, spurred mainly by the mining, transport and conversion of coal resources. If the oil shale industry develops in the area, large amounts of water would be needed for industrial and domestic purposes. The proposed Juniper-Cross Mountain project would consist of two separate hydroelectric developments, each having a dam, reservoir, powerplant, and associated facilities. The Juniper unit would have an installed capacity of 98,000 kw, while the Cross Mountain unit would have an installed capacity of 50,000 kw. Four additional potential conventional hydroelectric powersites have been identified in the basin. The combined installed capacity potential for these sites is less than 50 megawatts. The reach of the Yampa River within Dinosaur National Monument is being stud-

ied for inclusion in the National Wild and Scenic Rivers System. (Moore-SRC)
W82-03045

**THE INPUT-OUTPUT WATER TRANSACTIONS MODEL OF SUPPLY AND DEMAND,**
Colorado State Univ., Fort Collins. Dept. of Civil Engineering.
D. W. Hendricks, and R. W. Dehaan.
Water Supply and Management, Vol 5, No 4/5, p 317-330, 1981. 6 Fig, 1 Tab, 7 Ref.

Descriptors: *Water supply, *Model studies, *Water demand, Planning, Decision making, *Input-output analysis, Water supply systems, Case studies, South Platte Basin, Colorado.

This paper focuses on the basic guidelines for input-output water planning and the general application of the model in basin-wide planning. The major purposes are to demonstrate how a simple tabular display, the input-output water transactions table, can be constructed to represent a complex water system, and to indicate the utility of the table in water planning. The 1970 input-output table of the South Platte Basin depicts the system structure for innumerable transfers of water. These transfers give the 'fits' between the sources of supply and the demand sectors shown. The structure, implicit in the matrix, is formed by the water rights priorities and the commensurate physical facilities for water storage, conveyance, and distribution. The input-output table ties together all of the diverse components of a water resource system such that the relationships between the parts and the whole can be discerned. Such a display provides a framework for making judgments about alternative water supply alternatives in the context of political, environmental, and legal questions, as well as physical ones. It is, at the same time, a planning methodology and a core of information. (Baker-FRC)
W82-03055

**ON WATER AVAILABILITY AND DEMAND IN NIGERIA,**
Ibadan Univ. (Nigeria). Dept. of Geography.
J. O. Ayoade.
Water Supply and Management, Vol 5, No 4/5, p 361-372, 1981. 2 Fig, 8 Tab, 3 Ref.

Descriptors: *Water resources development, *Management planning, Resources development, Water quality, *Water supply development, River basin development, Decision making, Planning, Water demand, Water supply, *Nigeria.

A broad assessment of water resources in Nigeria is presented along with strategies for developing and managing the country's water resources to avert the danger of a serious water crisis in the future. Rainfall represents the gross water income of the country, and it is the ultimate source of water found in rivers, streams, ponds, lakes or wells. Rainfall is seasonal in its incidence all over the country, but the duration of the rainy season varies from about 10 months to about three months in specific regions. The country has three major watersheds. In terms of quality, most Nigeria rivers are generally turbid; they carry a high sediment load in suspension, particularly during the wet season. Unpolluted water is generally acidic and moderately hard. It is good for drinking and irrigation, though it must be purged of the suspended sediment load to make it potable, particularly during the rainy season. The chemical quality of much of Nigeria's groundwater is relatively high. Traditional means of water exploitation include direct collection of rainwater from roofs of buildings and extraction of water from spring streams, ponds and hand dug wells. The major problem in meeting water demands is that of development and management rather than of water availability. Efficient management is beset with problems, including finance, equipment, personnel and the institutional framework for managing water resources. These problems can only be solved by planning and wise use of resources based on sound knowledge of the nature and distribution of the nation's water resources potential. (Baker-FRC)
W82-03062

**AIRY HOLM DAM - KIELDER WATER SCHEME,**
Babtie, Shaw and Morton, Glasgow (Scotland).
For primary bibliographic entry see Field 8A.
W82-03070

**POTENTIAL WATER USE AND AGRICULTURAL PRODUCTION PATTERNS UNDER ALTERNATIVE WATER PRICES,**
Iowa State Univ., Ames. Center for Agricultural and Rural Development.
For primary bibliographic entry see Field 6B.
W82-03092

**POLICIES AND GOALS FOR CALIFORNIA WATER MANAGEMENT: THE NEXT 20 YEARS.**
California State Dept. of Water Resources, Sacramento; and the California State Water Resources Control Board, Sacramento.
Public Review Draft, Bulletin 4, June, 1981. 54 p, 13 Fig, 4 Tab.

Descriptors: *Water management, *Long-term planning, *Resources management, Groundwater management, *Comprehensive planning, *Project planning, *Water policy, Public policy, Water quality control, Water quality management, Projections, Regional planning, Regional development, *California.

Annual net water use in California is now about 29 million acre-feet. Drops in runoff and increased water transport costs have reduced the total usable surface water runoff to 26 million acre-feet per year from 71 million acre-feet. The California Water Resources Management Policy has been drawn up to guide federal, state, and local agencies to ensure that enough water of proper quality is available to meet the state's reasonable needs until the year 2000. The nine policy components are: (1) use of existing water resources before developing new sources; (2) consideration of water quality objectives as an integral part of water resources management; (3) encouragement of conjunctive water use and avoidance of ground water overdraft; (4) encouragement of water conservation; (5) encouragement of water reclamation and reuse; (6) control of point and nonpoint pollution sources; (7) enhancement of instream beneficial use; (8) control of floods by construction of facilities and by flood plain zoning, flood proofing and flood warning systems; and (9) encouragement of energy considerations as part of water resources planning. Present water supplies, along with authorized and proposed additions to the Central Valley Project and the State Water Project, will satisfy water needs in California until 2000 during years of normal and above-normal runoff, but local and regional water management agencies need to accelerate their efforts for more effective water management. More attention must be given to planning for water-short years, managing ground water supply and quality, protection of instream use, and monitoring 13 significant conflict areas in the state. (Garrison-Omniplan)
W82-03111

**WATER SUPPLY IN DENMARK,**
Copenhagen Water Supply (Denmark).
J. A. Husen.
Aqua, No 2, p 25, 26, 28, 1981. 1 Fig, 1 Tab.

Descriptors: *Water supply, *Groundwater budget, *Denmark, Groundwater management, Groundwater reservoirs, Wells, Boreholes, Irrigation, Potable water, *Groundwater availability.

While Denmark does not have any large rivers or inflowing watercourses, easy access to groundwater is possible almost everywhere. Thus the main part of the water supply is based on groundwater abstraction. Surface water is used only as a supplement in the area of the Capital. The average annual precipitation is 760 mm, and the average actual transpiration is estimated at about 410 mm per year, leaving about 350 mm per year for infiltration and run-off. Public water supply delivers less than half of the total consumption figure for the country. About 90% of the population are supplied from public water supplies organized either as municipal waterworks or as private cooperative waterworks owned by the consumers. About 3 million inhabitants are supplied from 150-200 municipal waterworks, for a total production of about 360 million cubic meters per year. Total consumption breaks down to about 63% for households and small firms, 27% to industry and about 10% to institutions. During recent years a special demand has risen for abstraction of groundwater for irrigation by drilling on individual farms. This has resulted in a considerable exploitation of the groundwater resource. For the country in general the groundwater resources are still sufficient, but careful planning of resources has been established, as it is necessary to keep a balance between standards of quality and quantity required and the effect on the environment. (Baker-FRC)
W82-03274

**QUANTIFICATION OF RAINFALL AND ITS UTILIZATION EFFICIENCY IN RAJASTHAN,**
Central Arid Zone Research Inst., Jodhpur (India).
For primary bibliographic entry see Field 2B.
W82-03276

**WATER: TOO MUCH, TOO LITTLE, TOO BAD,**
Johns Hopkins Univ., Baltimore, MD. Dept. of Sanitary Engineering and Water Resources.
A. Wolman.
Consulting Engineer (St. Joseph), Vol 57, No 3, p 83-86, September, 1981. 3 Ref.

Descriptors: *Water reuse, *Water supply, *Planning, *Water management, Water conservation, Water transfer, Water resources development, Water demand, Water policy, Water shortage, Irrigation, Drip irrigation, Agriculture, Hydroelectric power, Floods, Drought, Industrial water, Wastewater, Future planning, Long-term planning, Political aspects, Social aspects, Municipal water.

A bird's-eye view of water resources points out the $160 billion investment in 60,000 water systems in the U.S., the low price ($1 or $2 per 1000 gal, residential use), and the problems of sufficient water at the desired locations. Agriculture, the largest user of water in the U.S. is rapidly adopting drip irrigation, especially in drier regions. Industry has traditionally used water according to availability. For example, steel making uses 5000 gal per ton of steel produced where water is in short supply and up to 50,000 gal per ton where ample cheap water is available. New plants and process modifications are increasingly designed to conserve water. Cooling water continues to be a high-volume use, and further research is needed to develop a technology for conservation in this application. With higher oil costs, hydropower is regaining favor and many inactive dams are being considered for retrofitting to produce power. Floods and droughts continue to plague planners, zoning officials, and government officials. Efforts to prepare for or prevent these disasters are often ineffective and last only as long as a threat is perceived. Measures which may conserve water now and for the future are: water reuse, wastewater reuse, more effective irrigation, estuarine impoundments, and desalination. Systems analysis, operations research, computer intelligence data, and automation are among the tools available for confronting the problems of water management. (Cassar-FRC)
W82-03291

**WILL SYNFUEL DEVELOPMENT DRAIN THE WEST DRY,**
CH2M/Hill, Denver, CO.
M. R. Stansbury, and J. E. Patten.
Consulting Engineer (St. Joseph), Vol 57, No 3, p 91-96, September, 1981. 2 Fig, 1 Tab.

Descriptors: *Water requirements, *Synthetic fuels, *Coal gasification, *Oil shale, Water users, Water conservation, Water allocation, Water consumption, Water transfer, Water deficit, Water demand, Water law, Water management, Water policy, Water resources development, Water rights, Water scarcity, Water supply, Fuel, Coal mining, Slurries.

Large scale development of synthetic fuels in the water-short western U.S. would require large volumes of water. Oil shale production uses water for processing spent shale, cooling, dust control, and irrigation of revegetated areas. An average of 8500 acre feet of water per year is required for a 50,000 barrel per day facility. Water sources for this oil shale producing region are the Green, White, Yampa, and Colorado Rivers. With proper management and development of water a moderate level of oil shale development could be sustained. Synthetic fuels from coal also have large water requirements, depending on the extraction and pyrolysis methods used (4000-9000) acre feet per year for a standard size 15,000-30,000 tons per day high Btu coal gasification plant; 13,000-15,000 acre feet per year for a low Btu plant, standard size; and 4000-15000 acre feet per year for coal liquefaction plants). Transport of coal slurries would require 15,000-20,000 acre feet of Wyoming water to move 30-40 million tons of coal to Louisiana, and the water would be lost to the source state. Energy developments in the Upper Missouri Basin have and will continue to affect the agricultural community via declining water tables and the like. Possible solutions to the water deficit are: wastewater recycling, conjunctive use of groundwater and surface waters, conservation and reuse of irrigation return flow, and interstate and interbasin transfers. To prevent water supply crises the synthetic fuels industry should be limited to a moderate level of development over a long period. (Cassar-FRC)
W82-03292

**A PERSPECTIVE STUDY OF DROUGHTS IN MEXICO,**
National Water Planning Commission, Mexico City.
For primary bibliographic entry see Field 2E.
W82-03358

**JERSEY DROUGHT HASTENS WATER SUPPLY PROJECT,**
American Society of Civil Engineers, New York.
H. N. Tuvel.
Civil Engineering (New York), Vol 51, No 2, p 51-52, February, 1981. 1 Fig.

Descriptors: *Water supply development, *Water shortage, *Regional planning, *Drought, Water resources development, Water conveyance, Potential water supply, Planning, *New Jersey, Municipal water, Drinking water.

One of the areas of the northeastern United States hardest hit by water supply shortages in early 1981 is northern New Jersey, where a water emergency has been declared. Water suppliers and municipalities may impose penalties and fines for excess water usage. The Round Valley Reservoir, which is owned by the State of New Jersey, has about 75 percent of its water capacity available but is unable to relieve water suppliers in northern New Jersey due to the lack of interconnecting distribution systems. A comprehensive study of new sources of water supplies in the northeast was conducted in the late 1960s by the Army Corps of Engineers. However, no major water supply project in the Delaware River area was undertaken at that time, partially due to heavy rainfall and abundant water supplies in the seventies. The suppliers of water to northern New Jersey consist primarily of six purveyors, whose combined yields leave the area about 25 percent short of what is considered a safe yield. The mix of State, city, andprivately-owned purveyors with no central water planning and development agency with the authority to make resources development decisions resulted in the failure of the region to respond to the known need for additional water supplies. Although the North Jersey district Water Supply Commission is planning to build a new reservoir which will provide water to other purveyors, much of the current shortfall could have been avoided with adequate water resources management and development. (Carroll-FRC)
W82-03385

## 6E. Water Law and Institutions

**THE EVOLUTION OF TEXAS WATER LAW AND THE IMPACT OF ADJUDICATION,**
Texas Tech Univ., Lubbock. Dept. of Geography.
O. W. Templer.
Water Resources Bulletin, Vol 17, No 5, p 789-798, October, 1981. 5 Fig, 38 Ref.

Descriptors: *Water rights, *Adjudication procedure, *Riparian rights, *Texas, Legal aspects, *Water law, Institutional constraints, Irrigation water, Claims, Permits, Planning, Appropriation, Surface water, Water allocation, Water policy, Water management.

Texas' water law was first influenced by Hispanic legal principles. Lands granted by Spain and Mexico carried comprehensive riparian rights, including the implied right to use streams for irrigation. During 1840-1889 English riparian doctrines were superimposed on the existing water law, resulting in the popular assumption that riparian land owners could use as much water as desired for any purpose. This doctrine, unsuitable for arid and semi-arid regions, prompted the Appropriation Acts of 1889 and 1895. Under these acts, newly acquired land carried no riparian rights; individuals had to obtain water rights through statutory procedures. Loose administration of these procedures led to a stricter permit system introduced in 1913. With the mixture of conflicting laws and the uncertain riparian element, efficient management of the state's water resources was impossible. Finally, the Water Rights Adjudication Act (1967) was passed to merge all surface water rights claims (riparian and appropriative) into the permit system and to finally adjudicate all surface water rights. Over 11,600 previously unrecorded claims (7 million acre-feet) were filed as of 1974. Some of the expected benefits of water rights adjudication are: (1) riparian rights are limited to a maximum quantity of water, (2) unclaimed surface water will be discovered and made available for appropriation, and (3) reduction of unused paper rights will reduce claims to the amount of water actually being used, preventing waste flow into the Gulf of Mexico. After several more years of expensive adjudication procedures, Texas surface water rights will be well established, making efficient administration and planning possible. (Cassar-FRC)
W82-03085

**THE CANADA WATER ACT, ANNUAL REPORT 1980-1981.**
Department of the Environment, Ottawa (Ontario).
For primary bibliographic entry see Field 7C.
W82-03098

**EPA'S APPROACH TO REGULATING NEW ENERGY TECHNOLOGIES,**
Environmental Protection Agency, Cincinnati, OH.
D. G. Stephan.
AIChE Symposium Series, Vol 77, No 209, p 196-204, 1981. 4 Ref.

Descriptors: *Environmental policy, *Regulations, Environmental protection, Environmental effects, Administrative regulations, Standards, Water quality, Water management, Waste management, Fuel, Gasification, Coal gasification, *Energy technology.

The current approach of the EPA toward regulating new energy technologies is summarized, with the major emphasis being on water quality issues. EPA takes a great interest in the environmental implications of the manufacture of synthetic fuels, including coal liquefaction and gasification, retorting of oil shale, and the production of alcohol for fuel. Interest is also expressed in geothermal, solar, wind and tidal energy, combustion modification, coal and oil shale mining, energy conservation, fuel and energy transport and transmission, and new energy conversion systems such as ocean thermal gradients, magnetohydrodynamics, and fuel cells. In the area of pollution control guidance, the focal point of each regulation is intended to be a set of available control alternatives for each environmental discharge along with associated performance expectations and the basis for the alternatives presented. For most of the new energy technologies, exemplary full-scale and even pilot-scale waste treatment installations do not yet exist. A novel possibility now available is that of influencing in an environmentally productive way the choice by industry of the actual process technology to be commercialized and the overall designs of new plants, such that the most cost-effective environmental protection methods can be incorporated into the process design from the start. Specific energy technologies for which pollution control documents are now planned include low Btu coal gasification, indirect coal liquefaction, oil shale mining and processing, direct coal liquefaction, geothermal, medium Btu coal gasification, and high Btu coal gasification. Water-related environmental problems with synthetic fuels are also being studied, including the management of solid wastes from the production processes. (Baker-FRC)
W82-03129

**DON'T DAMN THE STANISLAUS,**
Lycoming County Planning Commission, Williamsport, PA.
T. Palmer.
National Parks, Vol 54, No 3, p 17-20, March, 1980. 4 Fig.

Descriptors: *Wild rivers, *Recreation, *Environmental effects, *Stanislaus River, *California, Legislation, White water, Rivers, Dams, *Reservoirs, Water resources development, Wildlife, Political aspects, Public opinion.

Construction of the New Melones Dam, completed in 1978 on the Stanislaus River, California, may drown the wildest remaining stretch of this popular white water stream. Already filled for 16 miles, the reservoir has not reached the white water stretch because a clear demonstration of public benefit and necessity has not been made and public pressure to stop filling at the present level has been great. Conservationists have disclosed many reasons for preserving this stretch of river. About 90,000 people annually use the area for rafting, hiking, fishing, and exploring the limestone caves. There are 600 identified archeological sites connected with the Miwok Indians and the Gold Rush era. A rare cave spider is among the 200 species of wildlife inhabiting the river environment. As of March 1980 a bill, HR 4223, to prevent further flooding of the valley was expected to reach the House floor. (Cassar-FRC)
W82-03275

**THE RISK BUSINESS,**
Thames Water Authority (England).
C. Sinnott.
Water, Vol 39, p 2-4, July, 1981. 4 Fig.

Descriptors: *Water policy, *Capital costs, *Budgeting, *Thames Water Authority, Planning, Institutional constraints, Expenditures, Utilities, Risks, Public utility districts, England.

When regional water authorities were formed in England in 1973-74, they inherited their predecessors' liberal capital spending aspirations. Government policy mandated a more restrained investment program, starting in 1979. In the Thames Water Authority these budget cuts caused increases in charges and decreased services. Four examples of water projects, now deferred to 1982, illustrate how this policy affects the consumers: insufficient water supplies in some areas, continued flooding of foul sewage during heavy rain, hazards of operating dilapidated sewage treatment plants which exceed pollution discharge standards, and disruption of navigation and irrigation from possible failure of a corroded and eroded weir. Sudden changes in investment levels, felt throughout the entire capital program, disturb long-term scheduling of construction, waste design effort, and may cause large fluctuations in work and expenditures. (Cassar-FRC)
W82-03281

**RIVER CLEAN-UP PLAN DEVELOPED WITH CITIZENS AND INDUSTRY,**
Fox Valley Water Quality Planning Agency, Neenah, WI.
For primary bibliographic entry see Field 5G.
W82-03283

**MUNICIPAL SEWAGE: THREE COMMUNITIES TRY TO COPE,**
For primary bibliographic entry see Field 5D.
W82-03284

**ENGINEERING U.S. WATER POLICY,**
V. Fairweather.
Civil Engineering (New York), Vol 51, No 9, p 148, September, 1981.

Descriptors: *Water policy, *Administrative decisions, *Federal jurisdiction, Public policy, Administrative agencies, Administration, Administrative regulations, Regulations, Operating policies, Policy making, Decision making, United States.

The future of water policy in the United States is summarized. Programs which are proposed for action must have cost recovery built into them. Matters of national economic interest will play an increasingly strong role in obtaining project approval. Recommendations to the cabinet from the group working on water priorities will probably include rescission of the current 'Principles and Standards' which govern water project assessment. New guidelines will be proposed. These guidelines will emphasize national economic objectives. Cost sharing and user charges will definitely be part of the water projects that win approval in the future. Fifty-two water projects that have been languishing at the Water Resources Council will probably be returned to their originating agencies to be reprioritized. The water working group will also probably recommend elimination of the independent review that had been sought by the previous Administration. The Assistant Secretary of the Army forecasts greater power on the part of the states in selecting water projects. Even so, regional projects or those with national interest must not be overlooked. Port development projects should get underway in this decade. Flood control projects are not viewed as of highest priority. The Assistant Secretary also hopes to get the Army Corps of Engineers out of the business of regulating permits in wetlands. (Baker-FRC)
W82-03294

**EPA MOVING TO CONTROL INDUSTRIAL TOXIC POLLUTANTS WITH NEW NPDES PERMITS,**
Environmental Protection Agency, Boston, MA. Region I.
S. J. Silva.
Civil Engineering (New York), Vol 51, No 9, p 76-78, September, 1981. 2 Tab.

Descriptors: *Industrial wastes, *Permits, Hazardous materials, *Wastewater treatment, Legal aspects, Regulations, *Wastewater disposal, *Water pollution control.

NPDES permits are generally written for a specific period of time, 5 to 10 years, and contain effluent limitations and monitoring requirements for each discharge point. For the most part these permits limited the conventional pollutants: biochemical oxygen demand (BOD), total suspended solids (TSS), oil and grease, pH, as well as ammonia, metals, and phenols. In 1977 the Clean Water Act was passed to focus attention on controlling toxic pollutants. By July 1, 1984, industry is to meet minimum technology requirements, which means the best available technology economically achievable must be used for controlling toxic pollutants, and best conventional pollutant control technology used to control conventional pollutants. Permit issuance procedures have changed little since 1973. The law requires the EPA to consider more stringent limits for conventional pollutants in the second round permits, but such limits will only be imposed where additional required facilities meet a cost-reasonableness test. EPA will review the treatment facilities employed to meet present requirements and then determine what logical modifications or additions might further reduce conventional pollutant levels. Major emphases of new permits will be the control of toxic pollutants. Reductions in pollutants will most likely be achieved by: optimization of existing treatment systems most industries installed to meet current requirements; isolation at the source and separate treatment; process chemical substitution; or housekeeping improvements. Large scale application of advanced wastewater treatment techniques is not expected. (Baker-FRC)
W82-03296

**THE RIVER RHINE--TRANS-NATIONAL RIVER BASIN MANAGEMENT DEVELOPING PROGRAMME TO MEET NEW CHALLENGES,**
Nordrhein-Westfalen Landesamt fur Wasser und Abfall, Dusseldorf (Germany, F.R.).
For primary bibliographic entry see Field 5G.
W82-03372

**CZ '80: COASTAL QUANDARIES PERSIST,**
V. Fairweather.
Civil Engineering (New York), Vol 51, No 2, p 57-58, February, 1981.

Descriptors: *Coastal zone management, *Governmental interrelations, Environmental policy, Environmental protection, Barrier islands, Interagency cooperation, Planning, State jurisdiction, Economic aspects, Ocean dumping.

Coastal Zone '80, a specialty conference sponsored by the American Society of Civil Engineers (ASCE), was held in November, 1980, to provide a forum for the discussion of ideas about the conflicting interests and overlapping jurisdictions involved in coastal zone management in the United States. Major issues discussed at the conference included the future of environmental protection efforts with respect to coastal zones, expected changes in Federal government regulations with respect to coastal zone management and development under the Reagan administration, the conflicts between states' rights and national interest, ocean dumping, development of the outer continental shelf, port expansion efforts, and fishing interests. The debate over the stabilization of barrier reefs where shifting sands and erosion have taken their toll was particularly intense. Means of balancing state and Federal interests were discussed. (Carroll-FRC)
W82-03383

## 6F. Nonstructural Alternatives

**NEW THRUST IN THE 1980S FOR U.S. WATER-QUALITY PROGRAMS,**
For primary bibliographic entry see Field 5G.
W82-03252

**DO WE NEED A NATIONAL WATER POLICY PROCESS. PRELIMINARY CRITERIA FOR DESIGNING A CONSTITUENCY-BASED WATER POLICY STRUCTURE,**
National Academy of Public Administration. Washington, DC.
D. C. Harrison.
Available from the National Technical Information Service, Springfield, VA 22161 as PB82-172206, Price codes: A07 in paper copy, A01 in microfiche. Report to National Academy of Public Administration, Washington, DC 20036. December, 1981. 173 p, 1 Fig, 140 Ref. 3 Append. 14-34-0001-1414.

Descriptors: *Water policy, Public policy, Planning, River basin planning, Regional planning, Comprehensive planning, Long term planning, Future planning, Management planning, *Governmental interrelations, Interagency cooperation, Political aspects, Institutional constraints, Institutions, Organizations, Local governments, State jurisdiction, Federal jurisdiction-governmental interrelations, Public participation, Constituency development.

The nation appears to have neither an integrated water policy process nor an institutional support structure that can make it work. This paper addresses institutional barriers to national water policy. It concludes that we cannot govern integrated surface and groundwater systems that flow across political boundaries and affect a multitude of competing interests with a fragmented, inefficient policy guidance structure that encourages division rather than sharing of our water resources. This paper offers preliminary conceptual guidance on how to reexamine intergovermental roles and relationships in the field of water policy. It describes a holistic conceptual model of the national water policy process and institutional support structure that will help to guide the design and evaluation of incremental improvements. Criteria for designing a 'constituency-based' water policy structure are taken from the interpretation and analysis of conflicts between management agencies and constituencies; between regions; and between other major institutional perspectives. The process that resolves these conflicts must provide lower levels of government with competence and with adequate representation in national water policy, and build the capacity to govern water resource systems. First priority must be given to the creation of a consitituency for an integrated water policy process. (Harrison-NAPA)
W82-03340

**BARRIER ISLANDS: SHOULD ENGINEERS INTERFERE WITH NATURE,**
V. Fairweather.
Civil Engineering (New York), Vol 51, No 5, p 64-67, May, 1981.

Descriptors: *Barrier islands, *Protection, Shores, Engineering, Regional development.

Questions concerning the construction of protection for barrier islands are presented. One major concern is with the cost of such protection and the question of who should pay for it. A second question deals with whether or not barrier islands can really be protected at all. Two environmentalist-backed bills in Congress call for an official no-development policy on undeveloped barrier islands and also for funds for government acquisition of undeveloped barrier islands. Currently, there appears to be a trend toward nonstructural approaches to coastal storm and erosion control. The most obvious nonstructural approach calls for no development whatsoever. Barrier island protection plans are discussed for Atlantic City, Cape May, San Francisco Bay area, North Carolina's Oregon Inlet, and others. Some engineers have suggested the use of dredging in certain situations, as opposed to other barrier island protective devices. It appears that barrier islands which have been developed will be protected, since they have economically viable communities. It is suggested that further development of barrier islands be stopped. (Baker-FRC)
W82-03377

## 6G. Ecologic Impact Of Water Development

**FINAL ENVIRONMENTAL IMPACT STATEMENT; NORTH FORK PAYETTE RIVER PROJECT FERC NO. 2930-IDAHO.**
Federal Energy Regulatory Commission, Washington, DC. Office of Electric Power Regulation.
Available from the National Technical Information Service, Springfield, VA 22161 as DE82-001984, Price codes: A12 in paper copy, A01 in microfiche. Report FERC/EIS-0027, October, 1981. 251 p, 18 Fig, 22 Tab, 58 Ref, 6 Append.

Descriptors: *Hydroelectric plants, *Environmental effects, *Recreation, *Dam effects, Alternative planning, Wild rivers, Boating, Scenery, Aesthetics, *Environmental impact statement, *North Fork Payette River Project, Idaho.

Idaho Power Company proposes to construct a 273-MW hydroelectric development that would be located on the North Fork Payette River, approximately 45 mi north of Boise, Idaho. The development would encompass a 15-mile reach of the river, and would include: two diversion dams, each

155 ft wide and 30 ft high, with a radial gate and flap gate; two pools, 600 to 700 in length; two 16-ft underground power tunnels; two surge tanks; two penstocks; two underground powerhouses; two tailrace tunnels, 3,600 and 760 ft long, returning water from the power houses to the North Fork Payette River, just upstream of the confluence with the South Fork; two switchyards; and a 230-kV transmission line. The energy generated by the proposed North Fork Payette River Project would make a significant contribution after 1986 to meeting projected energy requirements. An analysis of the feasibility of two hydroelectric and seven non-hydroelectric alternatives indicates that there are no reasonable hydroelectric alternatives, and that coal-fired steam-electric generation is the only reasonable non-hydroelectric alternative. Development of the proposed North Fork Payette Project would result in the following unmitigated environmental impacts: the loss of the recreational experiences, including boating opportunities, dependent on continuous whitewater for 15 miles of the river; a lessening of visual quality in the 15-mile reach of the river; the possible disqualification of the river as a potential candidate for inclusion in the National Wild and Scenic River System; and the removal of approximately 90 acres of timberland from production. (Moore-SRC)
W82-03046

**DON'T DAMN THE STANISLAUS,**
Lycoming County Planning Commission, Williamsport, PA.
For primary bibliographic entry see Field 6E.
W82-03275

**VERTICAL MIGRATION AND MORTALITY OF BENTHOS IN DREDGED MATERIAL. PART I: MOLLUSCA,**
Delaware Univ., Lewes. Coll. of Marine Studies.
D. Maurer, R. T. Keck, J. C. Tinsman, and W. A. Leathem.
Marine Environmental Research, Vol 4, No 4, p 299-319, 1981. 6 Tab, 36 Ref.

Descriptors: *Mollusks, *Migration, *Mortality, Dredging, *Spoil banks, Benthic fauna, Benthos, Invertebrates, Aquatic animals, Sediments, Estuaries, Temperature effects.

Benthic invertebrates have many characteristics which make them prime candidates for burial studies in dredged material. A major concern in dredging and disposal projects is the effect of burial on the survival of benthic invertebrates. The purpose of this study was to determine the ability of estuarine benthos, and in particular three species of mollusks (Mercenaria mercenaria, Nucula proxima, and Illyanassa obsoleta), to migrate vertically in natural and exotic sediments and to determine the survival of benthos when exposed to particular amounts of simulated dredged material. Mortalities generally increased with increased sediment depth, with increased burial time, and with overlying sediments whose particle size distribution differed from that of the species' native sediment. Temperature affected mortalities and vertical migration, with both being greater in summer temperatures than in winter temperatures. It was concluded that vertical migration is a viable process which can significantly affect rehabilitation of a dredged disposal area. Under certain conditions, vertical migration should be considered, together with larval settling and immigration from outside impacted areas, as a mechanism of recruiting a dredge-dump site. (Carroll-FRC)
W82-03317

# 7. RESOURCES DATA

## 7A. Network Design

**THE DEVELOPMENT OF WATER QUALITY MANAGEMENT PLANS USING DATA FROM AUTOMATIC STORMWATER MONITORING NETWORKS,**
Virginia Polytechnic Inst. and State Univ., Blacksburg. Dept. of Civil Engineering.
For primary bibliographic entry see Field 5G.
W82-03069

## 7B. Data Acquisition

**RAINFALL PREDICTION-MEASUREMENT SYSTEMS AND RAINFALL DESIGN INFORMATION FOR URBAN AREAS,**
Illinois State Water Survey Div., Champaign.
S. A. Changnon Jr., F. A. Huff, J. L. Vogel, D. A. Brunkow, and D. W. Staggs.
Circular 146, 1980. 63 p. 9 Fig, 14 Tab, 87 Ref, Append.

Descriptors: *Weather forecasting, Rain gages, Monitoring, *Rainfall, *Prediction, Precipitation, Computers, *Radar, Flood forecasting, Net rainfall, Weather data collections, Rainstorms, Site selection, *Remote sensing, Climatology,*Urban areas.

This report examines various systems for rainfall forecasting in urban areas and developes guidelines for their use by water management authorities. Most of the data were gathered from the Chicago Hydrometeorological Area Project (CHAP), which began in 1976 and concluded in 1979 with a 2 1/2-month demonstration program. Key elements in rain prediction systems are a radar system, recording raingages, a computer system, and a communication system to connect the components. A radar system provides a more accurate portrayal of storm rainfall than dense raingage networks and also yields data on approaching short-term (30-180 minute) forecasts. However, radar signals can make large errors, particularly with 5-cm equipment, so data in real-time from telemetered recording raingages are needed to adjust the radar-indicated rainfall. The types of gages and their optimal siting and installation are reviewed. A computer system translates digital radar data into rainfall estimates by integrating the raingage-indicated rainfall with the radar signal. It also calculates motion and rain change fields needed to predict urban rainfall. These data can be converted to a cartesian grid for analysis. Several types of communication links may be required, such as radar-raingage communication and radar system to user. A final section of the report covers the possible range of data analysis and interpretation needs that are available and applicable today as well as some future capabilities. A further discussion outlines the time constraints of objective forecasting techniques using radar observational data, and the role people and objective techniques play in rain forecasting for time frames over 3 hours. (Atkins-Omniplan)
W82-03008

**REMOTE SYNOPTIC SURFACE FLOW MEASUREMENTS IN SMALL BODIES OF WATER,**
Scripps Institution of Oceanography, La Jolla, CA.
D. Sheres.
PhD Dissertation, 1980. 110 p, 25 Fig, 5 Tab, 25 Ref, Append. University Microfilms International, Ann Arbor, MI; Order No GAX81-00037.

Descriptors: *Flow measurement, *Remote sensing, *Surface water, Aerial photography, Flow profiles, Wavelengths, Wave-Current interactions, Surface circulation.

A new approach to remote and synoptic surface flow measurements in small bodies of water is described and the investigation to determine the practicality of this technique is included. The approach is based on imaging monochromatic wavetrains, of known frequency, propagating over surface flows. It is shown that the wavelength and direction of two monochromatic wave trains of known frequency, at a region of interest, carry all the necessary information to determine the surface flow in that region. Experimental tests, conducted both in a wavetank and in a lagoon, utilizing inexpensive and readily available equipment, are described as well. These tests have shown the viability of this remote and synoptic surface flow measurement. Practical aspects of the measurements, such as vertically nonhomogeneous flow profiles, data processing of the aerial photos via 2D Fourier transforms, and the measurement of wavelength by photography of specular reflection of sun light from waves, are discussed. The extension of this measurement to coastal regions in the open ocean is briefly explored together with a preliminary experiment that tests the possibility of obtaining quantitative flow data from boat wave measurements. Such utilization of boat waves may enable surface flow measurements in areas otherwise inaccessible. (Sinha-OEIS)
W82-03012

**AN AERIAL TECHNIQUE FOR ASSESSING THE IMPACT OF COOLING WATER DISCHARGES ON RECEIVING WATER,**
State Univ. of New York Coll. of Environmental Science and Forestry, Syracuse.
J. R. Schott.
PhD Thesis, January, 1980. 142 p, 35 Fig, 10 Tab, 25 Ref. University Microfilms International, Ann Arbor, MI; Order No GAX80-19081.

Descriptors: *Remote sensing, Aerial photography, *Water temperature, Thermal pollution, *Temperature effects, Thermal plumes, *Cooling water, *Ecosystems, Environmental effects, Powerplants, Water quality.

This research demonstrated that aerial remote sensing could be a useful tool in studying the effect of power plant cooling water discharges on certain aspects of aquatic systems. Thermal infrared imagery, aerial color photography and laboratory models were combined to study the effects of cooling water discharges on aquatic ecosystems. A new technique for wholly airborne calibration of aerial infrared data was utilized permitting remote measurement of water surface temperatures to within 0.4 C plus or minus 0.3 C of actual values. In addition, color photography was used to monitor chlorophyll, lignin and yellowing organic concentrations in the vicinity of the power plant. This was accomplished using models developed in the laboratory relating the optical properties of water to the concentration values of various parameters in the water. The theory, testing and evaluation of the approach at a particular site are discussed. (Sinha-OEIS)
W82-03016

**USE OF ENVIRONMENTAL SATELLITE DATA FOR INPUT TO ENERGY BALANCE SNOWMELT MODELS,**
California Univ., Santa Barbara. Computer Systems Lab.
J. Dozier.
National Oceanic and Atmospheric Administration, National Earth Satellite Service, Washington, DC, December, 1980. 118 p, 24 Fig, 2 Tab, 73 Ref. 04-8-MO.

Descriptors: *Snowmelt, *Remote sensing, *Satellite technology, *Energy, Model studies, Canopy, Forests, Runoff rates, Temperature, Meteorological data collection, Snowmelt runoff.

Mapping snow surface temperature over a large alpine area is a useful tool for snowmelt runoff investigations. Tiros-N satellite data used to measure snow surface temperature over a large area have been calibrated with micrometeorological data from two remote stations in the southern Sierra Nevada, and from active field measurement of snow surface temperature using a radiant thermometer. Performance of the system under isolated alpine conditions has been satisfactory. Models for clear sky solar and longwave radiation have been developed and tested. The clear sky solar radiation model has been extended to calculate the necessary corrections for radiometric data over rugged terrain. A procedure for deriving an estimate of the spectral albedo of an extensive alpine snow cover from satellite spectral radiance measurements was demonstrated with Landsat digital imagery of the southern Sierra Nevada. The resultant spectral albedo measurements are adequate for input to an areally extensive energy-balance snowmelt model. Extensive point measurements of forest canopy densities were made during both winter and summer conditions. These will be extended over the area by correlation to satellite

brightness data. This information will then be used to model the effect of canopy cover on the snow surface radiation budget. (Moore-SRC)
W82-03048

**METHODS OF DISCHARGE COMPENSATION AS AN AID TO THE EVALUATION OF WATER QUALITY TRENDS,**
Geological Survey, Raleigh, NC.
D. A. Harned, C. C. Daniel, III, and J. K. Crawford.
Water Resources Research, Vol 17, No 5, p 1389-1400, October, 1981. 17 Fig, 1 Tab, 23 Ref.

Descriptors: *Water quality, *Discharge measurement, Flow rates, Water quality management, *Solute transport, Data acquisition, Lakes, Streams, Water analysis, *Streamflow-water quality relations.

This paper presents two new approaches to evaluating trends in stream water quality and tests the performance of the new methods against existing methods. One method, discharge normalization, adjusts daily discharges using a central value calculated for the period of record and recalculates daily specific conductance from the adjusted discharges and discharge versus specific conductance regressions. Normalized concentrations for many constituents can then be calculated from linear relationships between specific conductance and constituent concentrations. The second method, discharge-frequency weighting, weights each observed concentration by a fraction of the total area underneath the discharge-frequency distribution of the period of record. The weighted concentrations are summed for each year. Both normalized values and weighted values can be plotted against time to produce trends essentially independent from discharge effects. Results from the methods are statistically similar to each other and to results from other trend detection techniques. However, each method also has limitations. Both are limited to use of water quality data collected in conjunction with a continuous record of streamflow. Normalization also requires daily specific conductance records. (Baker-FRC)
W82-03056

**LARGE RAIN DROPS IN THE BRIGHT BAND,**
Rome Air Development Center, Hanscom AFB, MA. Electromagnetic Sciences Div.
E. E. Altshuler.
Nature, Vol 288, No 5790, p 464-465, December 4, 1980. 2 Fig, 6 Ref.

Descriptors: *Measuring instruments, *Fluid drops, Rain, Ice, Precipitation, Radar, Remote sensing, Rainfall rate, Rain drops, *Rain-drop size analysis, Distribution patterns.

A technique is described for inferring rain-drop sizes which produces results in support of the bright band model. Slant-path attenuation measurements at frequencies of 15 and 35 GHz were made in the Boston area during 8 storms of various intensities. A dual-frequency radiometer was the detector. Antenna beamwidths were about 9 and 4 arc min, respectively, and the center of the Sun was tracked with an accuracy of at least 0.5 arc min. Over 10,000 simultaneous measurements of attenauations at 15 and 35 GHz were made, and the ratios of these attenuations were plotted against the 15-GHz attenuations. If the rain drop size distributions along the slant path were similar to those measured on the ground, the attenuation ratios would have been of the order of 6 or 7 for low rain rates and decrease to about 4 or 5 for the higher rain rates, corresponding to higher 15-GHz attenuations. However, the bulk of the points plotted had ratios between 2 and 4 and occur for low 15-GHz attenuations. These results are thus not consistent with ground level rain drop size distributions. Instead they suggest that somewhere along the slant path there is a significant contribution to the attenuation which results from precipitation with characteristics of rain drops having very large effective drop diameters. Since most of the rain along the path occurs below the bright band, the attenuation contribution from the bright band would be expected to be relatively small. However, drop diameters of the order of 10-200 mm are certainly possible. It may be helpful to conduct both dual frequency attenuation and dual polarized reflectivity measurements to differentiate between rain and ice. The attenuation measurement easily distinguishes rain and ice, but this is not always the case with radar. (Baker-FRC)
W82-03065

**CONTINUOUS DISCHARGE MEASUREMENT FOR THE TRANSITION BETWEEN PARTLY FILLED AND PRESSURIZED CONDUIT FLOW IN SEWERAGE SYSTEMS,**
Technische Univ., Munich (Germany, F.R.). Inst. fuer Hydraulik und Gewasserkunde.
F. Valentin.
Water Science and Technology, Vol 13, No 8, p 95-102, 1981. 3 Fig, 2 Ref.

Descriptors: *Sewer hydraulics, *Flow discharge, *Flow measurement, *Pressure measuring instruments, *Flowmeters, Sewers, *Sewer systems, Flow profiles, Flow rates, Discharge measurement, Conduits, Measuring instruments, Venturi meters, Gages.

Conventional sewerage discharge measurement devices often are inadequate for control measurements in the sewerage system itself and may reduce channel width lowering upstream capacity. To improve upon this situation, hydraulic events occurring during the changeover from free flow to pressurized flow conditions and the possibility of continuous flow measurements under such circumstances were studied in simulated unsteady flow conditions. Maximum propagation velocities of over 200 m/sec during self priming were used while paying special attention to the self priming of the pipe in relation to sewage flow. Various commercially available instruments were tested with free surface flow and pressurized flow in the experimental pipe. During transient flow conditions, the Venturi flume was found to be inadequate. However, an electromagnetic flowmeter gave sufficiently accurate discharge measurements while allowing better knowledge of the transient flow itself. Improvement in the field of discharge measuring devices for the management of sewerage systems is still needed. (Geiger-FRC)
W82-03152

**REMOTE SENSING FROM SPACE-II.**
Civil Engineering (New York), Vol 50, No 4, p 63-65, April 1980. 2 Fig.

Descriptors: *Remote sensing, *Irrigation efficiency, *Aquifer management, Agriculture, Landsat, Ogallala Aquifer, *Satellite technology.

Landsat data are being used to improve estimations of irrigated crop acreage. The data can be used to regulate drawdown of the Ogallala Aquifer, which extends over north Texas and states north. To date the irrigated areas in two countries have been mapped by Landsat, and the procedure was found only 3-4% less accurate than higher-resolution 'classified' military imagery. In process is a study of using Landsat data for more efficient irrigation by detecting crop stress or soil dryness. (Cassar-FRC)
W82-03248

**EVALUATION OF INFILTRATION MEASUREMENTS FOR BORDER IRRIGATION,**
Science and Education Administration, Phoenix, AZ. Conservation Lab.
A. J. Clemmens.
Agricultural Water Management, Vol 3, No 4, p 251-267, 1981. 4 Fig, 8 Tab, 12 Ref.

Descriptors: *Infiltration, *Irrigation, *Border irrigation, Data collections, Soil moisture, Surface irrigation, Bouwer's method, Model studies, Ring infiltrometers, Agriculture.

Several methods for measuring infiltration in irrigation borders were evaluated--the ring infiltration method. Bouwer's method, and the zero-inertia border irrigation model. Ring infiltrometers, in use for many years, give good results if the ring is properly installed and operated, if measurements are made during an irrigation, and if a volume balance is maintained in the border. Data from ring infiltrometers are fitted to power functions for infiltration rate and cumulative infiltration rate vs. time and to a branch function where the infiltration rate is not allowed to drop below a minimum (final infiltration rate). Cumulative infiltration data are not reliable in sandy soils, but in general are less subject to error and fluctuation. Bouwer's method, using a series of borders as infiltrometers, is good in borders with uniform infiltration and within a large number of borders, but not when infiltration varies spatially. The zero-inertia border irrigation model, useful when good infiltration information is available, was used to study two cases of surface irrigation. (Cassar-FRC)
W82-03264

**REMOTE SENSING APPLICATIONS FOR RESOURCE MANAGEMENT,**
California Univ., Davis. Dept. of Land, Air and Water Resources.
C. J. Johannsen, and T. W. Barney.
Journal of Soil and Water Conservation, Vol 26, No 3, p 128-131, May-June, 1981. 8 Ref.

Descriptors: *Water management, *Remote sensing, *Data collection, Resources management, *Satellite technology, Aerial photography, Infrared imagery, Telemetry, Land management, Data interpretation, Erosion control, Watershed management, Data storage and retrieval, Data processing.

Remote sensing is the science and art of acquiring information about material objects from measurements made at a distance without coming into physical contact with the objects. Some applications of remote sensing devices to land and water management are described. Data bases can be used to analyze remotely sensed information. Geographic information systems are useful in gathering, storing, analyzing and disseminating data on natural resources and socioeconomic data. The use of remote sensing devices in the study of agriculture, rangelands, forestry, hydrology, geology, cartography, land use, thermography, environmental protection, oceanography, disaster warning, and human and animal health is examined. Remotely sensed data from satellites can provide a continuous flow of information about land cover and land use conditions to aid in soil erosion control in watersheds. Transfer of technology in remote sensing must increase to be of more value to resource managers. (Geiger-FRC)
W82-03279

**BACTERIAL UTILIZATION OF ALGAL EXTRACELLULAR PRODUCTS. I. THE KINETIC APPROACH,**
Middlebury Coll., VT. Dept. of Biology.
For primary bibliographic entry see Field 5C.
W82-03330

**RADAR MEASUREMENTS OF ESTUARINE CURRENTS AND TIDES,**
Birmingham Univ., (England). Dept. of Electronic and Electrical Engineering.
For primary bibliographic entry see Field 2L.
W82-03360

## 7C. Evaluation, Processing and Publication

**CANADA WATER YEAR BOOK 1979-1980, WATER RESEARCH DIVISION.**
Department of the Environment, Ottawa (Ontario).
Available from Canadian Government Publishing Centre, Hull Quebec, 132 p, 1981. Photos, Charts. ISBN 0-660-10878-X.

Descriptors: *Canada, *Water resources development, *Research, *Aquatic environment, Physical analysis, Wastewater treatment, Water quality, *Water management, Chemical properties, Biological properties, Wastewater disposal.

This is the fourth in the series of the Canada Water Year Book and reviews the principal activities in water research across Canada. Other years covered: water resources, water management, and water data. Water Research is explored through the nature and goals, research and development, and hydrological research. Major topics include: physical properties; chemical and biological processes in the aquatic environment; water quality; wastewater treatment and ultimate disposal; and water quality and water resources planning. (WATDOC)
W82-03096

**THE CANADA WATER ACT, ANNUAL REPORT 1980-1981.**
Department of the Environment, Ottawa (Ontario).
Available from Ministry of Supply and Services, Hull, Quebec, 1981, 44 p. ISBN 0-662-51561-7.

Descriptors: *Water resources management, *Water quality, *Nutrients, Public information program, Management, Regulations, Research, *Canada Water Act, Projects.

The report highlights the provisions of the Canada Water Act and briefly discusses the individual programs which have been or will be undertaken to meet these provisions. (WATDOC)
W82-03098

**CANADA WATER YEAR BOOK 1977-1978.**
Available from Canadian Government Publishing Center, Hull, Quebec, 120 p, 1978, Photos, Tab, Maps. ISBN 0-660-10142-4.

Descriptors: *Canada, *Hydrologic data, *Water resources development, *Data collections, Snow, Ice, Rivers, Streams, Lakes, Reservoirs, Groundwater, Navigable waters, Charting, Pollutants, Water uses, Information systems, WATDOC, Programs, *Water management.

This edition of the Canada Water Year Book provides a brief report on the numerous water data monitoring programs. It provides some background on most programs, explains when and why the programs were initiated, how they are conducted, what types of data are available and where the data can be obtained. The edition is presented under the following main topics: (1) Water Data Fills an Important Roll in Society; (2) Canada's Water Resources Range Between Wide Extremes; (3) Basic Programs for Collecting Water Data, ie. Water in the Atmosphere, Snow and Ice, Rivers and Streams, Lakes and Reservoirs, Ground Water, Charting Navigable Waters, Inventory of Water Pollutants and Information Systems, WATDOC; (5) Water Data of General Interest, ie. The Flood Damage Reduction Program, Water Power Development, Large Water Diversions in Canada and International Programs. Shore Damage Survey of the Great Lakes and Hydrological Atlas of Canada; and, (6) Water Resources Data Research. (WATDOC)
W82-03099

**PROGRAMMABLE HAND CALCULATOR PROGRAMS FOR PUMPING AND INJECTION WELLS: III. CONSTANT PUMPING (INJECTION) RATE, FULLY CONFINED AQUIFER, PARTIALLY PENETRATING WELL,**
Missouri Univ.-Rolla.
For primary bibliographic entry see Field 2F.
W82-03225

# 8. ENGINEERING WORKS

## 8A. Structures

**HYDRAULIC MODEL STUDIES OF THEODORE ROOSEVELT DAM - SOUTH SPILLWAY,**
Bureau of Reclamation, Denver, CO. Engineering and Research Center.
M. F. Young.
Report GR-81-10, May, 1981. 41 p, 24 Fig, 1 Append.

Descriptors: *Hydraulic models, *Spillways, *Overflow, *Flood damage, Erosion, Flood discharge, Flood protection, Dams, Spillway capacity, Model studies, Radial gates, *Theodore Roosevelt Dam, Salt River, Arizona.

Roosevelt Dam originally had two uncontrolled overflow spillways. During the 1930's, radial gates were installed on both spillways to provide extra reservoir storage. The spillways were cut into each abutment with each spillway crest oriented to continue the arch shape of the dam. This alinement creates many problems because the south spillway channels its flow directly toward the upper right training wall instead of downstream. During a flood in February 1980, the spillways operated with a combined discharge of approximately 73,500 cu ft/s. The south spillway overtopped the right training wall, cascaded down the slope, and entered the powerhouse. A downstream training wall that protected the highly jointed canyon walls from erosion was damaged, and a converted warehouse was also damaged by mud and water entering the lower floors. A 1:36 scale model was used to develop protective measures for this powerplant, the highly jointed downstream canyon wall, and other structures. Also determined from the model study were spillway and radial gate discharge capacity curves. The model showed that a 15-ft high extension to the right training wall would provide full protection for the powerhouse. A 200-ft long wall was found necessary to provide adequate protection for the lower canyon wall. An extension to this wall, angled toward the river channel, was also recommended to protect the warehouse. (Moore-SRC)
W82-03051

**COST-BENEFIT ANALYSIS OF THE EUPHRATES DAM,**
Norfolk State Univ., VA.
For primary bibliographic entry see Field 6B.
W82-03054

**AIRY HOLM DAM - KIELDER WATER SCHEME,**
Babtie, Shaw and Morton, Glasgow (Scotland).
H. G. Perfect.
Water Services, Vol 85, No 1026, p 389-392, August, 1981. 7 Fig, 2 Tab, 1 Ref.

Descriptors: *Dams, *Water supply, Water demand, *Scotland, Planning, Decision making, Water resources development, Water supply development, *Airy Holm Dam.

The Kielder Water Scheme has been devised to enable the Northumbrian Water Authority to meet expected increases in water demands in that section of Scotland well into the next century. The scheme will increase river abstractions on the Rivers Tyne, Wear and Tees by up to 900 tcmd. Water flow in the River North Tyne will be regulated by releases from Kielder Water. Nearly 60 km downstream on the River Tyne, water will be abstracted at Riding Mill Pumping Station. Total pumping capacity at Riding Mill Station will be 1092 tcmd, including standby. Transfer of water to the Rivers Wear and Tees will be through a 6 km long steel pipeline, 2 m in diameter, to a surge tank at Letch House. From here, water will flow by gravity through a 32 km long aqueduct, 2.9 m in diameter, constructed mainly in tunnel and capable of carrying up to 1180 tcmd. Airy Holm Dam will form a 250,000 cubic centimeter capacity reservoir to provide balancing storage for the operation of the transfer works. Construction is nearing completion, and it is anticipated that full commissioning will take place during 1981. Information is provided on the actual construction of the dam, including concrete mixes, grouting, embankment flanks, and instrumentation. (Baker-FRC)
W82-03070

**A NEW SEDIMENT TRAP EFFICIENCY CURVE FOR SMALL RESERVOIRS,**
Science and Education Administration, Beltsville, MD.
H. G. Heinemann.
Water Resources Bulletin, Vol 17, No 5, p 825-830, October, 1981. 6 Fig, 1 Tab, 11 Ref.

Descriptors: Reservoir deposition, *Trap efficiency, *Sedimentation, Design criteria, Reservoir design, Reservoir storage, Small watersheds, *Agricultural watersheds, Ponds, Reservoir capacity, *Reservoir silting, Agricultural reservoirs.

A new sediment trap efficiency curve was developed by analyzing data on 20 small agricultural reservoirs of 3,000 to 4 million cu m capacity. Only reservoirs with drainage areas of 15 sq miles or less were considered. Reservoirs of this type are built for flood control, small water supply, recreation, sediment control, or a combination of these. The new curve, which plots % sediment trap efficiency vs. capacity:inflow ratio, is slightly different from the Brune (1953) curve in common use. The volume allotted in reservoir storage for trapped sediment could be reduced by 4-10% according to the new curve, saving construction costs. (Cassar-FRC)
W82-03086

**PROVISION OF ENERGY REQUIREMENTS FOR REMOTE COMMUNITIES BY SMALL-SCALE HYDRO DEVELOPMENT,**
R. A. Everdell, and F. M. Near.
Canadian Water Resources Journal, Vol 6, No 3, p 143-162, 1981. 7 Fig.

Descriptors: *Hydroelectric plants, *Environmental effects, Water resources development, Dams, Powerplants, *Ontario, Small-scale hydroelectric plants, *Remote communities.

Small prefabricated hydroelectric generating stations have been installed at two sites in Ontario. The Mini Hydel stations are designed to operate at heads from 3 to 8 meters. Water is delivered to turbines via open flumes at lower heads and pressure casings at higher heads. Plant outputs are 100-400 kw. Francis turbines are used with a speed increaser gearbox and a standard generator. Generally, small hydro projects are compatible with the environment. Air quality and noise effects are negligible. Water quality is affected considerably during construction but minimally in the long term. The projects produce little impact on fish, wildlife, society, or esthetics. The Wasdell Falls Project and the Sultan plant are described in detail. Future developers of small hydro plants are advised to select sites needing minimal civil work, bypass excess flows, conduct thorough preconstruction surveys, seek permits a year before planned construction, schedule construction for a single summer season, choose easy-to-build designs, minimize custom modifications, and accurately estimate required resources and work schedules. (Cassar-FRC)
W82-03151

**WARMING UP TO GEOTHERMAL,**
P. A. Robbibaro, and A. O. Watson.
Drilling, Vol 41, No 13, p 180, 183, 186, 188, October, 1981.

Descriptors: *Geothermal resources, *Drilling equipment, *Well drilling, Hot brines, Heat, Corrosion, Wells, Steam, Geohydrology, Deep wells, Water circulation, Water resources development, Energy sources, Exploration, *Energy conversion, Hydraulic systems, *Design criteria, Materials, Engineering.

Exploration in geothermal resources imposes great demands on conventional drilling equipment. Four problems are high temperatures, abrasive formations, lost circulation, and highly corrosive fluids. Hydrothermal systems, the most abundant geothermal resources, produce high temperatures, 350-700 F, and high mineral concentrations, up to 300,000 ppm. These extreme conditions are responsible for collapsed or parted casings, cementing, metal fatigue, severe corrosion, and scale buildup. Mud heat exchange towers can lower temperatures in drilling fluids. An example of a vapor-dominated

system is the Geysers, north of San Francisco. Problems in this steam-producing field are disintegration of serpentine and well collapse, loss of circulation, low reservoir pressure, erosion, and corrosion. Methods for combating these difficulties include sealing compounds for fractures, air drilling (dust, mist, aerated mud, and stiff foam), and use of corrosion resistant materials. A major problem in hot dry rock exploration is the 300-400 F temperature range. This type of drilling is in the development stage. Conventional drilling, improved with more durable bits and more efficient techniques, and unconventional methods (pressurized water jet drilling and percussion drilling) are useful in development of wells in hot rock. Geopressured resources, also in initial development stages, range from 250 to 450 F. Scaling and corrosion of metal equipment and deterioration of rubber materials result from the heat and high mineral concentrations. (Cassar-FRC)
W82-03156

**CONCRETE OF THE DAM OF THE KIROVSKOE RESERVOIR,**
For primary bibliographic entry see Field 8F.
W82-03159

**EVALUATION OF THE EFFECTIVENESS AND RELIABILITY OF DRAINS OF THE TAILRACE OF THE PLYAVINYAS HYDROELECTRIC STATION,**
M. F. Rogal.
Hydrotechnical Construction, No 1, p 50-58, January, 1980. 6 Fig, 1 Tab, 5 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 1, p 28-34, January, 1980.

Descriptors: *Drainage engineering, *Well function, *Seepage, Hydroelectric plants, Drainage wells, Drainage systems, Drains, Wells, Well seepage, Soil engineering, Soil mechanics, Corrosion, Soil stability, Tailrace, Dams, Reservoir design, Plyavinyas Hydroelectric Station, USSR.

The drainage system of the Plyavinyas hydroelectric station was evaluated. The geology of the site is complex, consisting of stratified inhomogeneous soils with interconnecting artesian horizons. This paper concerns the drains in the right wall of the tailrace. It was necessary to drain this area because 30-40 m of soil, a natural surcharge, had been removed. A series of drain wells was constructed to prevent expansion of the sand foundation soils upon reservoir filling. Monitoring and inspection indicated that the seepage regime changed considerably after filling the reservoir. Some former discharge areas became recharge areas. Two cones of depression formed in connection with the drain wells. The capacities of most of the drain wells were 5-10 times lower than maximum design specifications. Sand filling and severe pipe corrosion in wells draining one wall created a flooding threat. Pumping of relief wells did not substantially lower the head in the malfunctioning wells because of seepage inhomogeneity. Evaluation of several variant drain schemes showed that 7 of the 17 wells in the problem area could be closed without danger of upward movement of the soil. (Cassar-FRC)
W82-03161

**GROUTING WORKS IN THE DIVERSION TUNNEL OF THE INGURI HYDROELECTRIC STATION,**
N. V. Dmitriev, E. S. Baranos, and V. A. Ashikhmen.
Hydrotechnical Construction, No 9, p 879-884, September, 1980. 3 Fig. Translated from Gidrotekhnicheskoe Stroitel'stvo, p 3-6, September, 1980.

Descriptors: *Tunnel construction, *Grouting, *Concrete technology, Productivity, Water transport, Hydroelectric plants, *Inguri hydroelectric plant, Hydraulic structures, Diversion structures, USSR.

Consolidation grouting in the 15 km diversion tunnel of the Inguri hydroelectric station amounted to 617,000 cu m using 113,000 holes. Fill-in grouting of 158,000 sq m was done in the tunnel crown. It was necessary to increase the monthly grouting output from 2000-3000 m to 20,000-25,000 m during the later phase of the project. Drilling-grouting frames and semiautomatic central grout plants in combination with concrete placing units coordinated the general construction with grouting so that the tunnel was completed on schedule. The record grouting output was 55,500 m in the month of September 1978. (Cassar-FRC)
W82-03164

**INFLUENCE OF GEOLOGY ON TUNNELLING CONDITIONS AND DEFORMATIONAL BEHAVIOR OF SUPPORTS IN FAULTED ZONES A CASE HISTORY OF THE CHHOBRO-KHODRI TUNNEL IN INDIA,**
Central Mining Research Station, Dhanbad (India). J. L. Jethwas, B. Singh, B. Singh, and R. S. Mithal.
Engineering Geology, Vol 16, No 3/4, p 291-319, November, 1980. 16 Fig, 6 Tab, 29 Ref.

Descriptors: *Tunnel construction, *Tunnel linings, *Tunnel failure, Tunneling, Geologic fractures, Rocks, *India, Hydroelectric plants, Dam construction, Chhibro-Khodri Tunnel.

Problems associated with highly squeezing rock masses found in recurring faulted zones have delayed the construction of the Chhibro-Khodri Tunnel, part of the Yamuna Hydroelectric Scheme near Dehradun in the lower Himalayan region of India. Attempts were made to measure the tectonic slip along a fault zone running across the tunnel, and the suitability of a flexible lining for this region was evaluated. Inadequate surface and subsurface geological investigations contributed to inappropriate site selection for the tunnel. The elasto-plastic theory was used to provide an assessment of rock pressure, and a flexible support system consisting of steel arches with loose backfill caused significant load shedding. The heading supports underwent severe buckling and bending under the influence of side pressure in squeezing rock conditions when invert struts were not provided. This contributed to delays in the project. The monthly rate of tunnel radial closure at the time of stabilization ranged from 0.05 to 0.10% of the radium of the opening. (Small-FRC)
W82-03181

**RECENT WATER TOWERS IN NORFOLK,**
Anglian Water Authority, Norwich (England). Norwich Sewage Div.
K. Rowe.
Water Services, Vol 85, No 1023, p 236, 241, 242, May, 1981. 1 Tab.

Descriptors: *Hydraulic structures, *Water tanks, *Storage tanks, Design criteria, Economic aspects, Concrete construction, Norfolk, *United Kingdom.

A review is presented of the design of modern water towers in Norfolk, United Kingdom. There is a lack of standardization in the water industry in the design process and efforts are sometimes lacking to be economical in construction methods or to reduce required maintenance costs. Five towers are described which vary in size from 220 cu m to 2200 cu m. Three were constructed of reinforced concrete, one of reinforced stressed concrete, and one of steel. Total costs ranged from 38,000 British Pounds Sterling to 367,093 British Pounds Sterling. In a tower, the depth of water should be less than 20 m, and it is better to use a rubber water bar at critical joints. Watertightness is of fundamental importance, and no corners should be cut in this regard. Future designs should consider other potential development on the site such as office space. Radio towers can be located on roofs, which will provide additional income. If public access is necessary at the site, the security of the water must be considered. (Small-FRC)
W82-03246

**TVA'S PUMPED-STORAGE PLANT.**
Civil Engineering (New York), Vol 50, No 6, p 84-87, June, 1980. 1 Fig.

Descriptors: *Pumped storage, *Rockfill dams, *Hydroelectric plants, Dams, Hydroelectric power, Powerplants, *Tennessee Valley Authority, Raccoon Mountain, Tennessee.

The Raccoon Mountain pumped storage plant near Chattanooga, Tennessee, is capable of generating 1530 MW of electricity for 20 hours before the upper reservoir needs to be refilled. The 230 ft high compacted rockfill dam, using 10 million cu yards of material, is TVA's largest rockfill dam. The silo-like intake structure is designed to eliminate vortex action during generation. The pump/turbines are the most powerful in operation--525,000 hp as turbines and 3850 cfs at 1000 ft as pumps. The generator motors are the highest capacity reversibles in the world--425,000 kVA as generators and 547,000 hp as motors. The 35,000 acre-ft storage capacity of the upper reservoir gives the plant flexibilty in operation. (Cassar-FRC)
W82-03250

**RESEARCH NEEDS: HYDRAULICS, COASTAL ENGINEERING AND IRRIGATION,**
Civil Engineering (New York), Vol 50, No 4, p 83-87, April, 1980. 1 Fig.

Descriptors: *Civil engineering, *Research priorities, Erosion control, Dam failure, Risks, Benthic fauna, Water pollution effects, High flow, *Irrigation, Shore protection, Water use, Wastewater treatment, *Coastal engineering.

The hydraulics-coastal irrigation-engineering subgroup of the American Society of Civil Engineers-National Science Foundation held a workshop on research needs in civil engineering. At the workshop a number of research priorities were determined: processes involved in scour and deposition in rivers, predicting dam failures, design criteria for high velocity flows, risk analysis for dams, impact of sediments in waste plumes on benthic fauna, physical modeling of shore protection structures, conflicts between irrigation and western energy projects, necessary treatment level of municipal wastewater for ocean disposal, irrigation methods in humid areas, and irrigation energy efficiency. (Cassar-FRC)
W82-03254

**DON'T ALWAYS PUT DAM IN NARROWEST PART OF VALLEY,**
Laboratorio Nacional de Engenharia Civil Lisbon (Portugal). Dept. of Hydraulics.
F. Abecasis.
Civil Engineering (New York), Vol 50, No 6, p 93-94, June, 1980. 2 Fig.

Descriptors: *Dams, *Erosion, *Hydroelectric plants, Structural engineering, Spillways, Design criteria, Sediment deposition, Energy dissipation.

The hydraulic problems encountered in high arch dams built in narrow valleys may offset the cost savings in construction. Potential difficulties are: river bed erosion in the jet-impingement zone, eroded material in the tailrace tunnels, and bar formation downstream of tunnels. A hydropower project on the Douro River between Spain and Portugal is an example. The 330 ft Picote Dam, put into operation in 1958, is a double curvature arch with a 456 ft long crest. The water discharges along the spillway surface and passes over a ski jump energy dissipator. A pit 65 ft deep and a bar 50 ft high have formed downstream, causing the upstream water level to rise and reduce the head at the turbines. Repair and maintenance work required a $1 million tunnel to divert flow from the work area. Bar removal and river bed repair is difficult and has interfered with power production. The five-year old Cabora-Bassa project, 490 ft high, 755 ft crest dam, has shown no serious problems as yet, but modeling studies indicate potential erosion and bar formation. These problems might have been avoided by building the dam in a wider reach of the valley or using gravity or buttress construction. (Cassar-FRC)
W82-03282

**VALUE ENGINEERING SAVES DAM PROJECT,**

Converse Ward Davis Dixon, Inc., San Francisco, CA.
E. A. Miller, and G. S. Salzman.
Civil Engineering (New York), Vol 50, No 8, p 51-55, August, 1980. 1 Fig, 1 Tab.

Descriptors: *Construction costs, *Dams, *Seepage control, Engineering, Rockfill dams, Spillways, Bentonite, *Elgo Dam, Dam sites, Slurries, Water resources development, *Arizona.

The Elgo Dam, east of Phoenix, Arizona, was built after value engineering reduced the projected costs by 25% or $1 million. Revised plans required relocation of the dam site 750 ft upstream to take advantage of a natural rock ridge for the spillway site and using local materials for the 71 ft high, 1000 ft long earth and rockfill dam. The new design also provided for a central impervious core with a wider cross sectional area and flatter upstream and downstream slopes. Although the volume of embankment materials was double that of the original design, transportation costs were greatly reduced. Water seepage under the embankment was controlled by a cement-bentonite cutoff wall. (Cassar-FRC)
W82-03287

**GAO FINDS MASSIVE FAILURE OF WASTEWATER TREATMENT PLANTS,**
For primary bibliographic entry see Field 5D.
W82-03299

**THE EL CAJON HYDRO PROJECT IN HONDURAS, PART TWO,**
Empresa Nacional de Energia Electrica, Tegucigalpa (Honduras).
A. Diaz Arriviallaga, and H. Kreuzer.
International Water Power and Dam Construction, Vol 33, No 3, p 37-39, March, 1981. 7 Fig, 5 Tab.

Descriptors: *Dam design, *Spillways, *Diversion, *Financing, El Cajon Project, *Honduras, Rivers, Hydroelectric plants, Powerplants, Construction.

This paper, a continuation of a description of the El Cajon hydroelectric project, Honduras, concentrates on spillway facilities, river diversion, and financing. The spillway has a design inflow of 14,300 cu meters per sec into the reservoir. Spillway facilities include three components: a tunnel spillway, a crest spillway, and bottom outlets. During the 2.5 years of construction, the Humuya River will be diverted by an arrangement of two cofferdams and one diversion tunnel. An underground power station will be located next to the canyon wall. Systematic rock supporting, impermeabilization treatment, and leakage drainage are planned. A 600 meter tunnel will provide access from the road to the power station. Financing for the $582.7 million project will be provided by international financial institutions, the Honduras government, suppliers, and commercial banks. (Cassar-FRC)
W82-03332

**PUMPED-STORAGE DEVELOPMENT IN BRAZIL. PART III,**
Centrais Eletricas Basilieras S. A., Rio de Janeiro (Brazil).
R. M. Ciarlini, and W. Jordao.
International Water Power and Dam Construction, Vol 33, No 3, p 40-42, March, 1981. 2 Fig, 3 Tab.

Descriptors: *Pumped storage, *Hydroelectric plants, *Peak loads, Powerplants, *Brazil, Planning, Electric powerplants, Dam design, Reservoir design.

In the final part of a three-part series, four sites for proposed pumped storage plants for peak power supply in Brazil are described. These projects, Pacatuba (near Fortaleza), Amaraji (near Recife), Pedra do Cavalo (near Salvador), and Primavera, vary from 500 to 1000 MW. Some plan to use existing upper or lower reservoirs and spillways to reduce capital costs. Since all available heads in existing hydroelectric plants are under 100 meters, it is not economical to convert from base load to peak load plants. The excellent pumped-storage potential in Southeastern Brazil ensures a good selection of inexpensive projects with investment costs in the range of $200-260/kw. At some of the proposed sites, slow reservoir filling or pumping of water from nearby rivers may be necessary in order to avoid depleting local stream and groundwater. Pumped storage facilities can provide low cost energy for peak consumption periods, reducing the needed capacity of future hydroelectric plants. (Cassar-FRC)
W82-03381

**WHY BOTHER WITH HISTORIC PRESERVATION,**
National Trust for Historic Preservation, Washington, DC.
R. Wilson, and D. C. Jackson.
Civil Engineering (New York), Vol 51, No 2, p 66-67, February, 1981.

Descriptors: *Construction, *Archaeology, *History, Preservation, Civil engineering, Engineering, *Dams, Earthquakes, Check structures.

Just as the excavation of prehistoric remains has been thought to delay construction projects, it has also been argued that the avoidance of historical engineering structures or their removal to safety is a waste of time and money. Archeological resources within a construction project area will almost always be adversely affected by the construction activity. Once they are destroyed, they cannot be replaced or reconstructed. If there is no alternative to destruction of an important archeological site, time and access should be provided for scientific study before the site is destroyed. The Archeological and Historic Preservation Act of 1974 incorporates specific language which ensures that future archeological study will not unduly delay construction without recompense. Two examples of historical dams are used to illustrate how an understanding of and appreciation for engineering history helped to resolve a modern problem. In one case, a contractor exposed a large wooden structure during excavation for a sewer line. After the Advisory Council on Historic Preservation halted construction, it was discovered that the structure was part of a timber dam built to impound the waters of a lake only 25 feet from the sewer trench. The trench was realigned to avoid any direct impact on the dam. The Littlerock Dam is a reinforced concrete, multiple arch dam constructed in 1923-1924. The California Department of Water Resources attempted to force drainage of the dam in 1977 on the basis of earlier studies suggesting the dam was unsafe. An independent in-depth study of the design employed showed that the engineering characteristic of the dam, when considered as a whole, made it safe in withstanding earthquakes and capable of handling heavy rains. Court action has resulted in the continued operation of the dam, which operated successfully during heavy floods in 1978. (Carroll-FRC)
W82-03384

## 8B. Hydraulics

**POWER CHARACTERISTIC CURVE OF HYDRAULIC TURBINE SET,**
Yu. U. Edel, L. P. Mikhailov, A. M. Chistyakov, and Yu. A. Kharlamov.
Hydrotechnical Construction, No 9, p 941-944, September, 1980. 3 Fig, 4 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 9, p 38-40, September, 1980.

Descriptors: *Turbines, *Head loss, *Design criteria, Hydraulic design, Hydraulic structures, Hydraulic turbines, Penstocks, Corrosion, Nozzles, Operating policies, Power characteristic curves.

The power characteristic curve of a hydraulic turbine, furnished by the manufacturer, reflects the relation among turbine efficiency, allowable draft head, capacity, and head acting on the turbine. This curve does not consider the head losses in the head and tailrace conduits (turbine set). The operating characteristic curves for a 3-turbine high head plant are shown as follows: (1) turbine efficiency for 1 turbine, (2) turbine efficiency for 3 turbines, (3) turbine set efficiency for 1 turbine with new penstock, (4) the same, with a corroded penstock, (5) turbine set efficiency for 3 turbines with new penstock, (6) the same, with a corroded penstock, and (7) efficiency of turbine and turbine set for turbines operating on 3 out of 6 nozzles. The first 4 curves were close, differing by no more than 1.5% at full capacity (54.6 MW each turbine), and less at partial capacity. There was a 5% difference in efficiency at full capacity between curves (2) and 85) and 10% between curves (2) and (6). Maximum efficiencies for each turbine were about 91% at 26-40 MW for the first 4 curves, 90% at 24-30 MW for (5), 89% at 20-28 MW for (6), and 91% at 20 MW for (7). At low heads, differences between optimal regimes of the turbine and turbine set are small enough to ignore. The operating curve of the turbine set should be included in the design procedure. It may show that the turbine dimensions and/or specific speeds should be increased. (Cassar-FRC)
W82-03163

**ABSOLUTE ROUGHNESS OF CONCRETE-LINED CHANNELS,**
Department of Water Affairs, Pretoria (South Africa).
J. P. Pansegrouw.
Civil Engineer in South Africa, Vol 23, No 7, p 307, 309, 311, 313, 316, July, 1981. 8 fig, 3 Tab, 10 Ref.

Descriptors: *Roughness coefficient, *Channels, Mannings equation, *Linings, Concrete technology, *Concretes, Hydraulics, *South Africa, Concrete lined channels.

Observations were made at four major schemes of the South African Department of Water Affairs, Forestry and Environmental Conservation on absolute roughness and Manning n values in concrete-lined canals. During the study a number of important advantages of the method using roughness measurements to determine friction coefficients such as Manning n values were observed on site. When compared with the method of estimating Manning n values from the general appearance of cross-sections or from illustrations in textbooks, the roughness method has the advantage of minimizing errors due to faulty or subjective misinterpretations. This is particularly the case when friction coefficients are to be appraised for complex sections with composite roughness characteristics. No major disadvantages of the roughness method could be reported, except that roughness measurements can only be taken during dry or virtually dry periods. This could not be considered to be a real obstacle, however, as it is always advisable to inspect the wetted perimeter of any conveyor on site and to take actual measurements of the cross-sections to establish the hydraulic radius, regardless of the method used to determine friction coefficients in practice. (Baker-FRC)
W82-03397

## 8C. Hydraulic Machinery

**INFLOW PREDICTION AND COOPERATIVE OPERATION OF PUMPS, VALVES AND GATES IN STORM WATER DRAINAGE SYSTEM,**
Hitachi Ltd. Kawasaki (Japan). Systems Development Lab.
M. Shioya, S. Shimauchi, H. Ogasawara, and T. Ohto.
Water Science and Technology, Vol 13, No 8, p 61-67, 1981. 6 Fig, 3 Tab, 2 Ref.

Descriptors: Regression analysis, *Drainage systems, Prediction, *Control systems, Pumps, Valves, Combined sewer overflows, Storm drains, *Storm sewers, Storm water, Storm runoff, Mathematical studies, Forecasting, Intake gates, Sewer systems, Combined sewers, Overflow control.

The possibility of inflow prediction using data from an actual pump station and the simultaneous operation of control pumps, valves and gates to prevent overflows during storm conditions are examined. A multiple regression analysis was used to

assess the potential accuracies of short time range inflow predictions. For time ranges of 10, 20 and 30 min, the means of the absolute values of the relative prediction errors were 0.24, 0.35 and 0.36, respectively, corresponding to 43.0, 52.5 and 53.3% of the discharge quantity of a pump handling 200 cu m/min. Short time range predictions were deemed adequate for pump operation control when a stand-by pump was provided. To handle excess stormwater, a control system of gates, pumps and valves was devised which determines the opening angle of gates or valves and the number of pumps required to prevent overflow. This control scheme may also function during partial failure of routine drainage operations. The present technology is recommended for future total control systems for entire combined storm drainage-sewer systems. (Geiger-FRC)
W82-03068

**TVA'S PUMPED-STORAGE PLANT.**
For primary bibliographic entry see Field 8A.
W82-03250

**MUNICIPAL WASTEWATER TREATMENT PLANT PIONEERS IN CONSERVATION APPROACH,**
Pirnie (Malcolm) Inc., White Plains, NY.
For primary bibliographic entry see Field 5D.
W82-03255

## 8D. Soil Mechanics

**CRACKING, LEAKAGE, AND EROSION OF EARTH DAM MATERIALS,**
Trondheim Univ. (Norway).
E. I. Hjeldnes, and B. V. K. Lavania.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 106, No GT2, p 113-135, February, 1980. 1 Tab, 13 Fig, 15 Ref.

Descriptors: *Erosion, *Construction methods, *Dams, *Earth dams, *Rockfill dams, Tension, Finite element analysis, Soil properties, Soil tests, Soil types, Soil stability, Hydraulics, Fluid mechanics, Flow characteristics, Experimental design, Design criteria, Dam stability.

A laboratory approach to determining the cracking, leakage, and erosion properties of soil simultaneously is described. This approach is intended for use in studies of the stability of earth dams and for selection of suitable core materials. With this method, a soil sample is encased in a hollow cylindrical apparatus. It is given a vertical pull, at a predicted rate of tensile deformation, to develop cracking in a horizontal plane at the center height. The desired hydraulic gradient is applied through it at the fracture plane; the leak discharge and the soil contents in the discharge are measured during the tests. The observations are then plotted to characterize the properties. The applicability of the approach has been demonstrated by testing two soil types, a silty-gravelly sand and a silty-clayey fine sand. Results showed that the silty-gravelly sand is superior to the silty-clayey fine sand for use in an earth dam because it has self-healing response to erosion and is more leak and crack resistant. (Titus-FRC)
W82-03149

**METHOD OF DETERMINING MECHANICAL CHARACTERISTICS OF COARSE SOILS,**
O. A. Pakhomov.
Hydrotechnical Construction, No 4, p 370-374, April, 1980. 5 Fig, 5 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 4, p 26-29, April, 1980.

Descriptors: *Soil physical properties, *Cohesionless soils, Soil mechanics, Soil physics, Model studies, Particle size, Shear tests, Compressibility, Dam construction, Earth dams, Rockfill dams, *Hydraulic structures.

A successive approximation method was developed to determine the mechanical characteristics of coarse soils used in constructing foundations for hydraulic structures. The new method does not have the limitations of commonly used procedures, which can only be used for soils with small differences in grain size. Five or six prototype mixtures of coarse soil are analyzed for particle size distribution and curves are prepared. Laboratory tests on specimens are conducted using consolidometer, stabilometer, shear apparatus, etc. A graphic relation between the investigated characteristics and the uniformity coefficient is plotted and an empirical equation selected. Extrapolation of the investigated relation produces the desired characteristic of the soil from the prototype particle size distribution for various load increments. Increases in modeling scale increase the error, but an accuracy of 5% may be attained with proper selection of the test unit dimensions. The method is illustrated by determination of compressibility and shear strength of a gravel-pebble soil. Specimens were 620 mm in diameter; the maximum size of prototype material was 200-500 mm. Five model mixtures were prepared by successive screening of fractions larger than 80, 40, 20, 10, and 5 mm. (Cassar-FRC)
W82-03160

**CALCULATION OF EARTH DAMS BEING UNDERMINED,**
A. K. Bugrov, and V. F. Markevich.
Hydrotechnical Construction, No 4, p 366-369, April, 1980. 3 Fig, 9 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 4, p 24-26, April, 1980.

Descriptors: *Subsidence, *Dam stability, *Stress analysis, *Soil mechanics, *Earth dams, Soil dynamics, Mining engineering, Deformation, Strain, Elastic properties, Plasticity, Dam foundations.

The mixed problem of plane strain is solved for a 30 meter high earth dam located within the marginal part of a subsidence trough caused by mining of a potassium mineral deposit. Spreading of the ground surface is the characteristic form of deformation in the marginal areas. The stress and strain of earth fills can be calculated by considering elasticity and plasticity. A figure shows the plastic regions for various values of spreading (horizontal extension strains). The mixed problem gives a more realistic picture of strains than a linear solution. The mixed problem is also applied to calculating the parameters of a subsidence trough. (Cassar-FRC)
W82-03162

**CALCULATOR PROGRAM AIDS LAGOON DESIGN,**
Gutierrez-Palmenberg, Inc., Phoenix, AZ.
For primary bibliographic entry see Field 6A.
W82-03211

**EARTH-FILLED SLURRY WALLS PROVIDE ECONOMICAL SEEPAGE CONTROL,**
R. A. Antonino.
Civil Engineering (New York), Vol 50, No 4, p 72-74, April, 1980. 3 Fig.

Descriptors: *Trenches, *Slurries, *Seepage control, Bentonite, Cofferdams, Backfill, Dewatering, Tombigbee River, Dam construction, Construction, Locks, Earth dams, Soil mechanics, Excavation, Waterways.

Slurry trench cutoff walls have been efficient, effective, and economical at two sites under construction at the Tennessee-Tombigbee Waterway for excluding groundwater during excavation and subsequent concrete construction. Although this technique is often used for seepage control after construction, it is unusual to use it during both excavation and construction. In addition, the slurry is unusual--a mixture of graded, select fill material and bentonite. At the Aliceville Lock and Dam site a cofferdam 2 km in circumference encircling 64 acres has an earth slurry wall 3 ft wide and 30 ft long extending from inside the cofferdam to an impervious underlying clay stratum. After building the cofferdam 6 ft high, the slurry trench was dug down to the impervious layer and filled with the mixture. The trench was then backfilled with slurry and soil until the wall extended along the perimeter of the circumferential trench. The remainder of the cofferdam fill was added to the working surface to bring the embankment to full height. The earth-slurry walls, in place for two years, have shown excellent seepage control. Costs are limited to the installation cost. There are no operating costs as in dewatering systems using pumps and wells. (Cassar-FRC)
W82-03256

**VALUE ENGINEERING SAVES DAM PROJECT,**
Converse Ward Davis Dixon, Inc., San Francisco, CA.
For primary bibliographic entry see Field 8A.
W82-03287

**RESPONSE OF BURIED STRUCTURES TO TRAVELING WAVES,**
California Univ., Berkeley. Dept. of Civil Engineering.
R. N. Hwang, and J. Lysmer.
Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol 107, No GT2, p 183-200, 1981. 9 Fig, 2 Tab, 14 Ref.

Descriptors: *Seismic waves, *Pipelines, *Underground structures, Waves, Construction, Strain, Strain measurement.

The response of underground structures such as pipelines to traveling seismic waves is discussed. A new approach is presented for computing the response of these structures using the finite element method. Soil structure systems are represented by three-dimensional finite elements. Using a special type of wave-transmitting element, a three-dimensional system can be reduced to a plane of finite elements with three degrees of freedom at each node while the traveling effects of waves are retained. Large structures were found to significantly reduce computed strains, probably because the rigidity of the structures provides resistance to deformation. Thus, large structures should not necessarily be designed based on strains developed in the free field. Also, the assumption of vertically propagating waves was found inadequate for predicting stresses and strains induced in underground structures. Proper consideration must be given to the traveling effects of waves in the design. (Small-FRC)
W82-03346

## 8F. Concrete

**NEW TECHNICAL SOLUTIONS USED FOR CONCRETING TUNNELS OF THE NUREK HYDROELECTRIC PLANT,**
G. P. Kopyshev, S. V. Shutenkov, A. S. Efimov, V. A. Serebryakov, and I. I. Mel'nikov.
Hydrotechnical Construction, No 9, p 885-891, September, 1980. 5 Fig. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 9, p 7-10, September, 1980.

Descriptors: *Underground structures, *Hydroelectric plants, *Tunnel linings, Water transport, Concrete technology, *Hydraulic structures, Linings, *Nurek Hydroelectric plant, USSR, Diversion structures.

New concrete technology was developed for constructing the reinforced concrete linings of three 10 m diameter headrace tunnels and the troughs of the horseshoe-section diversion tunnels in the Nurek hydroelectric plant, U.S.S.R. A OKSh-10 circular walking formwork increased productivity because a railway track was not necessary and because placing and replacing of the formwork was mechanized. A special trough concreting UBL installation permitted mechanized railway track placement. These technical solutions increased the quality and efficiency of the construction. (Cassar-FRC)
W82-03150

## Group 8F—Concrete

**CONCRETE OF THE DAM OF THE KIROVSKOE RESERVOIR,**
L. M. Garkun, T. S. Vorotovova, E. S. Zhirkov, and T. E. Nikitina.
Hydrotechnical Construction, No 2, p 153-157, February, 1980. 3 Fig, 4 Tab. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 2, p 27-29, February, 1980.

Descriptors: *Dam construction, *Concrete technology, *Kirovskoe Reservoir, *Buttress dams, Companion studies, Design, Construction materials, Technology, USSR.

Kirovskoe, the concrete buttress dam constructed in 1971-75 on the Talas River, U.S.S.R., used 2 grades of concrete: 279,000 cu meters of 25 MPa and 50,000 cu meters of 20 MPa. The latter was used in buttresses and downstream heads of the sections. Tests of the concrete after construction showed that it conformed to design specifications with respect to compressive strength and cleavage tensile strength. Laboratory tests showed that concrete homogeneity improved as the project progressed because of improvements in preparing the aggregates and in manufacturing and installing the concrete mix. (Cassar-FRC)
W82-03159

**CAVITATION RESISTANCE OF CONCRETE,**
Y. P. Inozemtsev.
Hydrotechnical Construction, No 2, p 158-160, February, 1980. 1 Fig, 11 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 2, p 30-31, February, 1980.

Descriptors: *Cavitation, *Concrete mixes, *Aggregates, Erosion, Gravel, *Hydraulic structures, Design criteria.

Comments on a paper by Moskin (1978) on cavitation erosion of concrete hydraulic structures are given. Moskin advocated use of broken stone instead of gravel to improve cavitation resistance. This is criticized on 3 grounds: (1) broken stone in place of gravel does not improve cavitation resistance, (2) more cement is required and the resulting higher heat produced increases the likelihood of thermal cracking, and (3) broken stone is scarce in remote regions. (Cassar-FRC)
W82-03165

## 8G. Materials

**LINERS OF NATURAL POROUS MATERIALS TO MINIMIZE POLLUTANT MIGRATION,**
Arizona Agricultural Experiment Station, Tucson.
For primary bibliographic entry see Field 5G.
W82-03028

**A SUITABLE LINING TECHNIQUE FOR EXISTING DISTRIBUTARIES,**
Irrigation and Power Research Station, Amritsar (India).
G. S. Dhillon, and T. Singh.
Water Supply and Management, Vol 5, No 4/5, p 339-349, 1981. 5 Fig, 5 Tab, 9 Ref.

Descriptors: *Linings, *Channel improvement, Polymers, Plastics, Canal linings, Canals, *Seepage control, Materials, *India, Punjab area.

Seepage losses have been observed from various distributaries and watercourses in different areas of Punjab, India. The losses observed after lining showed that considerable savings in seepage losses were effected due to the application of the lining. A combination type of lining was developed which is quite suitable for lining the existing distributaries and minors. The time needed to line pipes with this method is short, and lining can be executed during short closures of the channel. The combination lining fulfills the requirements of durability, impermeability and hydraulic efficiency. The lining is not affected by animal traffic nor by weathering conditions. The cost of the lining is low compared with other types of linings. The lining is a 400 gauge polythene film under 30.0 cm thick soil cover for lining at the bed. In the case of channels which are not in regime, polythene film at the bed is also overlaid with brick masonry. To improve the bond between the PE film and the brick masonry, bitumen emulsion was applied cold on the PE film and sand was sprayed before laying the brick masonry. (Baker-FRC)
W82-03063

**WARMING UP TO GEOTHERMAL,**
For primary bibliographic entry see Field 8A.
W82-03156

**EVALUATION OF THE MECHANICAL PROPERTIES OF THE MASS OF A CONCRETE DAM WITH INTERBLOCK JOINTS,**
K. A. Abadzhyan, E. S. Argal, and V. M. Korolev.
Hydrotechnical Construction, No 9, p 901-909, September, 1980. 5 Fig, 7 Tab, 5 Ref. Translated from Gidrotekhnicheskoe Stroitel'stvo, No 9, p 15-20, September, 1980.

Descriptors: *Concrete testing, *Deformation, *Grouting, Dam stability, Physical properties, Stress analysis, Strain measurement, Compressibility, Materials engineering, Strength, Cracks, *Hydraulic structures.

The deformability and character of fracture of interblock (nongrouted) and grouted joints were investigated on plaster-sand and concrete specimens using resistance strain gages. A mass with undisturbed joints in compression across the joints is as strong as or stronger than a monolith. Cracks in monolithic specimens develop parallel to the direction of action of the compressive forces. When cracks form in a jointed mass, they develop in the same direction but usually end at a joint, promoting better redistribution of stresses. Masonry with joints, either grouted or nongrouted, has increased deformability, but the average modulus of deformation under compression can be assumed equal to the modulus of deformation of the concrete. (Cassar-FRC)
W82-03158

**UNDERGROUND AND OFFSHORE: WHEN TO CONSIDER CATHODIC PROTECTION,**
Hinchman Corp., Detroit, MI.
A. L. Claes.
Consulting Engineer, Vol 54, No 3, p 89-92, March, 1980. 9 Fig.

Descriptors: *Corrosion control, *Cathodes, *Underground structures, Conveyance structures, *Pipelines, Water mains, Storage tanks, Coatings, Protective coatings, Anodes, Electrodes, Inspection, Maintenance.

Cathodic protection is an effective corrosion control method for structures immersed in water or buried in earth, such as pipelines, water lines and tanks, and sewage lines and outfalls. Direct current discharged through anodes travels through soil or water to the structure (the cathode) to be protected. Corrosion occurs only at the anode, which is periodically replaced, sparing the structure. The battery operated, low amperage and voltage galvanic anode system is used for structures with small current requirements--small coated pipes, sewage lift stations, etc. The impressed current system, externally powered and more flexible, can handle several hundred amperes and is used for structures with large current requirements, bare pipes and large cast iron water lines. Cathodic protection works most efficiently when coordinated with protective coatings and other corrosion control methods. Proper maintenance includes anode replacements and regular inspections, especially after any structural changes. (Cassar-FRC)
W82-03349

**WASTEWATER TREATMENT: CORROSION SOLUTION ARE AS VARIED AS PROBLEMS,**
Engineering Science, Inc., Atlanta, GA.
D. Burstein, and T. Franklin.
Consulting Engineer, Vol 54, No 3, p 83-88, March, 1980. 2 Tab.

Descriptors: *Corrosion control, *Hydrogen sulfide, *Industrial wastes, Wastewater treatment, Sulfuric acid, Cavitation, Aeration, Metals, Maintenance, Coatings, Plastics, *Wastewater treatment facilities.

A major maintenance problem in industrial wastewater treatment facilities is corrosion, caused by three basic mechanisms: erosion and cavitation, chemical attack, and galvanic and electrochemical attack. Corrosion attacks not only metal equipment, but also concrete, especially in material alternately wet and dry. Factors promoting corrosion are: low pH, high temperature, dissolved oxygen, dissolved salts, and high fluid velocity. A common corrosive material in the treatment process is sulfuric acid, formed from hydrogen sulfide in contact with wet equipment, Four basic methods are used in corrosion control in wastewater facilities: elimination of the corrosive agent or environment, use of protective liners and coatings, use of galvanic and impressed current protection devices, and use of corrosion resistant materials. H2S formation may be prevented by maintaining sufficient oxygen in the sewers entering the plant by injecting air into the wastewater or by adding chlorine. Corrosive vapors may be exhausted. Many specialized coatings are available for corrosion protection--painting, epoxy coatings, and plastic base liners and coatings. Corrosion resistant materials which may be used are: plastics (lowest cost), nonferrous metals, stainless steel (usually AISI Types 302, 304, and 316), and acid-resistant concrete. (Cassar-FRC)
W82-03350

**CORROSION ROUNDTABLE--OPPORTUNITIES/PITFALLS FOR NEW MATERIALS,**
M. Garbrecht.
Consulting Engineer (St. Joseph), Vol 54, No 3, p 70-80, March, 1980.

Descriptors: *Resins, *Corrosion control, *Materials engineering, Standards, Quality control, Wastewater treatment facilities, Engineering, Research priorities, Design standards, Legal aspects.

A panel discussion on new materials for corrosion prevention centered on fiberglass reinforced polyester resins (FRP) and included several points relevant to the water and wastewater industry. One problem in selecting materials for water plants is that the users often resist the idea of spending extra money for long term corrosion prevention. The uncertainty in the performance of unproven materials and the lack of sophistication of many clients causes engineers to use tried and true materials, rather than the innovative alternatives. There are many similar FRP plastic materials available, and as yet no standards and codes to give confidence to the users. Quality assurance is difficult. Newer wastewater process and complex industrial sludges present more exotic corrosion problems than in the past. In some cases, historically used materials are not applicable and FRP appears promising. Nevertheless, the tendency toward litigation in the case of failure makes engineers very cautious in specifying polyester resins. The record of FRP has been mixed to date. In one instance it was found that a piping system with 23,000 feet of pipe, many turns and bends, and thousands of fittings had only three leaks. In another case, a chemical waste storage tank failed because the designers did not consider the fact that benzene in the waste would destroy the resins. The panel urged more education and information dissemination, codes and standards, and more innovative applications of FRP. (Cassar-FRC)
W82-03373

**STOPPING WATER WITH CHEMICAL GROUT,**
Avanti International, Houston, TX.
W. B. Jaques.
Civil Engineering (New York), Vol 51, No 12, p 59-62, December, 1981. 1 Fig, 1 Tab.

Descriptors: *Waterproofing, *Oil sealants, *Grouting, Tunnels, Acrylamide grouts, Urethane grouts.

Chemical grouts are available to control water movement in soils, to repair sewer leaks, for waterproofing structures, and to stabilize incompetent soils. Unlike cements or epoxy resins applied to the inside of tunnels or foundations, the chemical grouts treat the water problem on the wet side of the structure. Several basic families are available. The most common is acrylamide grout, which requires three chemicals mixed at the time of use to form a solid material after a predetermined gel period. Although acrylamide grouts are not currently manufactured in the U.S., they are legal to use and may be imported. Urethanes may form stiff gels or foams. These materials have a wide range of applications, including one approved for potable water applications. Polyacrylamides include Injectite-80, a sewer sealing grout. AC-400, an acrylate, is specifically designed for controlling infiltration in sewer joints, but has also been used in tunnel sealing. Chemical grouts start as thin solutions which flow like water into very fine spaces between soil particles. Zones of any desired shape may be constructed--vertical walls, horizontal layers, and surrounding tunnels. (Cassar-FRC)
W82-03396

# 10. SCIENTIFIC AND TECHNICAL INFORMATION

## 10C. Secondary Publication And Distribution

**CANADA WATER YEAR BOOK 1979-1980, REFERENCES.**
Department of the Environment, Ottawa (Ontario).
Available from Inland Waters Directorate, Ottawa, 1981. 69 p, ISBN 0-662-51566-8.

Descriptors: *Bibliographies, *Canada, Aquatic environment, *Water quality, *Water resources development, Planning, Wastewater treatment, Wastewater disposal, Chemical properties, Biological properties, Water management.

Many of the authors contributing to the 1979-1980 Year Book provided numerous references to the literature to document their findings and to help indicate some of the important areas of research related to their discipline. These references have been arranged herein by chapter and section corresponding to the layout of the subject matter in the Year Book itself. The references are produced in English, French or German, according to the language in which the original report was produced. (WATDOC)
W82-03097

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## Subject Fields

1 NATURE OF WATER

2 WATER CYCLE

3 WATER SUPPLY AUGMENTATION AND CONSERVATION

4 WATER QUANTITY MANAGEMENT AND CONTROL

5 WATER QUALITY MANAGEMENT AND PROTECTION

6 WATER RESOURCES PLANNING

7 RESOURCES DATA

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10 SCIENTIFIC AND TECHNICAL INFORMATION

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SUBJECT INDEX

AUTHOR INDEX

ORGANIZATIONAL INDEX

ACCESSSION NUMBER INDEX

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**Customers in Canada, United States, and Mexico please use this price schedule; other addressees write for Folder PR-360-4.**

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| A01 | $4.00 | E01 | $6.50 | T01 | $110.00 |
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| A03 | 7.50 | E03 | 9.50 | T03 | 210.00 |
| A04 | 9.00 | E04 | 11.50 | T04 | 300.00 |
| A05 | 10.50 | E05 | 13.50 | T04 | 360.00 |
| A06 | 12.00 | E06 | 15.50 | T06 | 420.00 |
| A07 | 13.50 | E07 | 17.50 | T07 | 480.00 |
| A08 | 15.00 | E08 | 19.50 | T08 | 540.00 |
| A09 | 16.50 | E09 | 21.50 | T09 | 600.00 |
| A10 | 18.00 | E10 | 23.50 | T10 | 660.00 |
| A11 | 19.50 | E11 | 25.50 | T11 | 720.00 |
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| A13 | 22.50 | E13 | 31.50 | T13 | 840.00 |
| A14 | 24.00 | E14 | 34.50 | T14 | 900.00 |
| A15 | 25.50 | E15 | 37.50 | T15 | 960.00 |
| A16 | 27.00 | E16 | 40.50 | T16 | 1,020.00 |
| A17 | 28.50 | E17 | 43.50 | T17 | 1,080.00 |
| A18 | 30.00 | E18 | 46.50 | T18 | 1,140.00 |
| A19 | 31.50 | E19 | 51.50 | T19 | 1,200.00 |
| A20 | 33.00 | E20 | 61.50 | T99 | * |
| A21 | 34.50 | E99 | * | | |
| A22 | 36.00 | | | | |
| A23 | 37.50 | N01 | 30.00 | | |
| A24 | 39.00 | N02 | 50.00 | | |
| A25 | 40.50 | | | | |
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